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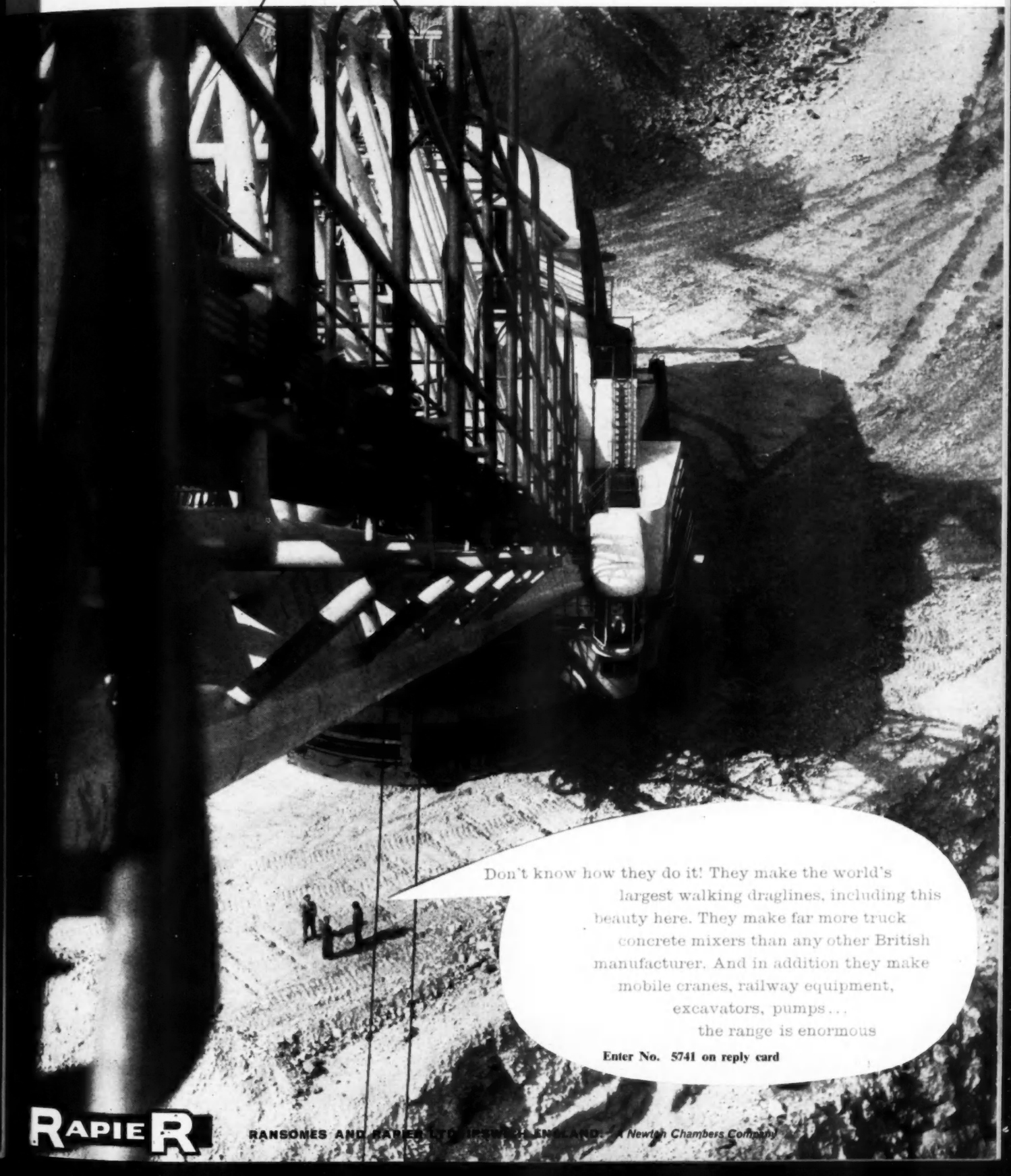
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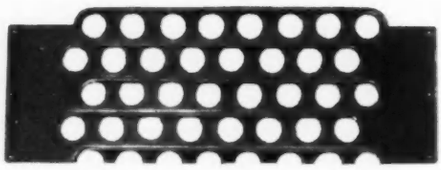

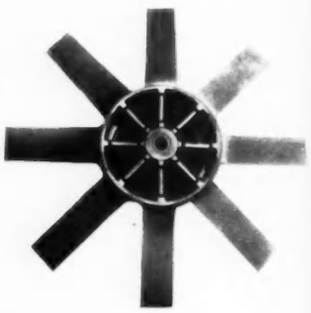

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No. 5504 **JULY 21, 1961** VOL. 212

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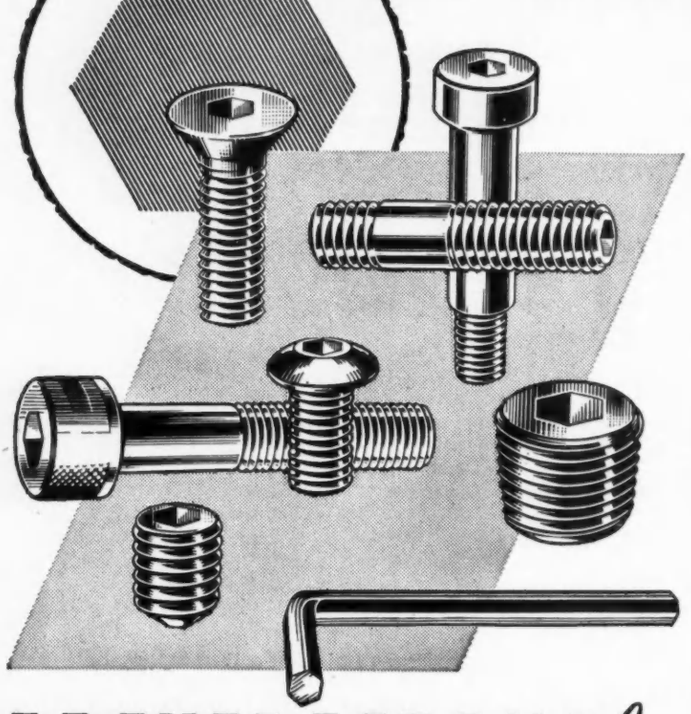

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THE ENGINEER

No. 5504 JULY 21, 1961 Vol. 212

STATE OF BRITISH MARINE INDUSTRIES

Last week shipping and shipbuilding were debated in Committee of Supply when attention was drawn to the present position of both industries. It was pointed out that there was a £25,000,000 deficit in our shipping services last year and that their net earnings of foreign exchange had fallen to about £100 million from about £220 million in 1952. Operating against British owners are the flags of convenience fleets, now representing a significant percentage of world tonnage, the owners of which pay virtually no taxes on profits, and flag discrimination by means of which governments direct cargoes to ships flying their own flag. A similar effect, it was mentioned, is achieved by import and export licences, bilateral trade agreements, exchange control and other expedients, while another adverse factor is the payment of subsidies by foreign governments. There is also the existence of an excess of shipping capacity associated with depressed freight rates. Concerning shipbuilding, the whittling down of the order book from 7,000,000 tons to 3,000,000 tons was noted, as was the drop in the percentage of world tonnage being built in British yards, a drop which has been closely paralleled by the reduction in the tonnage for export. Reference was made to the Exports Credits Guarantee Department and to the credit terms, such as a down payment of 30 per cent and the remainder spread over seven years, available in Japanese, German, Dutch, French and Greek yards.

The Minister of Transport, on behalf of the Government, recalled that the British merchant fleet is still the largest in the world and that the speed of ships is higher. With regard to dealing with flag discrimination, he was not against retaliation provided that it was to Great Britain's advantage. He referred to the investment allowance and the recommendation that the disparity between the expenditure on research for shipping and on transport should be reduced and to the need to combine research in shipbuilding and shipping. Turning to shipbuilding Mr. Marples commented on modernisation schemes and management and the drop in the tonnage built for export, the comparative figures being Germany 70 per cent, Sweden 65 per cent, Holland 40 per cent and the United Kingdom 15 per cent of the total output. He felt it a tragedy that British owners had found it necessary to place orders abroad; such orders amounted to 225,000 tons, 420,000 tons and 360,000 tons respectively for the years 1958, 1959 and 1960. An inquiry into the reasons revealed that British prices were, on average, 20 per cent higher, and delivery was either longer or could not be guaranteed, whereas foreign yards accepted a guaranteed date because some had long term labour agreements and were practically strike free compared with the 350,000 days lost last year in British yards. To assess the competitiveness of these yards the Government has appointed a firm of chartered accountants to analyse the reasons for orders going abroad, taking account of degree of modernisation, quality of management, excessive number of unions, demarcation, restrictive practices and shortage of skilled labour due to unions' restrictions on apprentices. The Minister made the point that high wages must be linked with higher productivity and that while strikes of workmen damaged the industry a strike of customers would be ruinous. It behoved Britain to make freely a new methodical approach to the solution of the problem or it would be imposed upon her by the harshness of events.

Most of the facts and figures stated in the debate are well known to the industry and have been highlighted in the D.S.I.R. report, the document issued by the General Council of British Shipping and the report of the Shipbuilding Advisory Committee. In a world of expanding economic nationalism, the creation of national flag fleets has resulted in British fleets being a smaller percentage of the world fleet, which is in excess of requirements and has caused a depression in freight rates despite an increasing volume of trade. The narrowing of the competitive field and the weighted competition set by flag discrimination, flags of convenience, and subsidies have removed the commercial basis of international trade and modified the law of supply and demand. To prevent the inevitable shrinking of the merchant fleet the Government should adopt firm counter-measures against discrimination, agree that there is no profit for taxation until provision has been made for fleet replacement, and grant financial aid where the existence of a British shipping service is threatened by subsidised competition.

With new yards in many countries building ships for prestige purposes there must be a reduction in tonnage offering for competitive tendering, while the existence of a world shipbuilding capacity in excess of requirements puts an even keener edge on competition. The position is not new. After all at the turn of the century Britain was building for Germany, France, Japan and Italy, all countries which have their own industry and are now competitors. With regard to the present competitive position, apparently there are examples of British quotations being too high so that orders have gone abroad. But since orders have been won in the open market it appears that some yards are competitive and this, coupled with a recent statement by a British builder that his quotation at less than cost was undercut by a considerable margin, suggests that foreign prices did not depend solely on building costs. Credit facilities also play their part and British builders should be able to offer the same terms as those given abroad. Many yards have been modernised at considerable cost to their own resources, and are equipped to build expeditiously by modern techniques: the building of a 12,000 ton deadweight cargo boat in twenty-one weeks by Austin and Pickersgill, Ltd., is an example of what can be

accomplished by one of the modernised yards. This is an example of what can be done: nevertheless, it must be discouraging to builders to learn that the industry is to be re-rated and that the improvements effected at considerable cost will incur a higher rateable value and add to the building costs. Perhaps the Government can modernise its approach to this problem.

Shipowners have to operate in world markets and so cannot pay more for their ships than their competitors or accept delay in delivery. These are hard economic facts, remorseless in their effect, which have to be met by effort on the part of management and men, and it devolves upon the former to give the latter an insight and understanding of the difficulties in organising to meet competition. Both members of the team must use to full advantage new materials, methods and machines, and appreciate that their incorporation into the shipbuilding scene will affect established trades and crafts and call for dynamic management and greater flexibility of labour. This may well involve some amalgamations of unions to avoid narrow lines of demarcation or restrictive practices. The labour content in the selling price is an important factor and can nullify the cost benefits gained by the installation of new machines and from planned work flow. Management must be allowed to manage, agreements made be kept, the unenviable records of days lost by strikes and other stoppages be expunged, and the confidence of customers be regained. The decline in the industry must be halted and the position restored not by any incantation of witch doctors or waiting for the philosophers' stone to turn up, but by the industry putting its own house in order: a political formula is no substitute for the stark realisation and acceptance of unpalatable facts coupled with a determination to get on with the job.

A MERGER REJECTED

Members of the Institution of Municipal Engineers have now finally rejected the proposals for amalgamation with the Institution of Civil Engineers. It may be recalled that regional voting at a number of centres to settle the question was decided upon at the I.Mun.E. special general meeting held in Brighton last month; furthermore the Council of the Institution was instructed by that meeting that a majority of 66⅔ per cent would be necessary for amalgamation to proceed. The results of this last vote were announced last Friday; 1342 members voted in favour of amalgamation, and 1020 voted against; that is a majority of 56.8 per cent in favour, with just under 40 per cent of the membership voting. The stipulated majority was not reached, so the matter has been dropped. These merger negotiations have been going on for over three years, and last February is seemed likely that they would be successfully concluded. At that time, a postal ballot attracted votes from 85 per cent of the I.Mun.E. membership, of whom 62 per cent were in favour of amalgamation.

Sir Herbert Manzoni well stated the principle behind amalgamation when the voting papers for this earlier ballot were sent out (both Institutions voted on that occasion, a majority of 75 per cent of the I.C.E. votes favouring amalgamation). "The ultimate aim," he wrote, "should be that of one society of professional engineers whose certificate members should be chartered engineers". This ultimate aim seems a long way off, longer now than it did last October when the voting papers were sent out. There has never before been so great a need as today for the engineering profession to be able to speak with one voice, and to exercise its influence nationally in a constructive and imaginative manner, towards directing the activities of technology into the most fruitful channels. Without some influence, broad principles may well go unstated, or be overlooked, or the pattern of advance distorted. These are matters which require the broadest approach, and cannot be dealt with adequately by the existing fragmented organisation of the profession. Perhaps a merger between the I.Mun.E. and the I.C.E. would have made little or no difference to this state of affairs, but at least it would have been a step in the right direction. Some opponents of amalgamation in the I.Mun.E. membership suggested an alternative, a "federation" to which all engineering institutions could belong. It will be interesting to see whether anything constructive emerges from this suggestion, or whether, now that the votes have been cast, it will be stillborn.

WORK OF INDUSTRIAL RESEARCH ASSOCIATIONS

A Report on work done by industrial research associations during 1960 entitled "Research for Industry 1960" has just been published by H.M. Stationery Office. This Annual Report proves to be no less interesting this year than it usually is. Indeed we often find it makes more interesting reading than Reports on the work of laboratories which come more directly under the control of the Department of Scientific and Industrial Research. For the research association laboratories are more often concerned to solve practical industrial problems and to develop new designs than are the D.S.I.R. laboratories. The point is well brought out when a section of the Report entitled "Review of Achievement" is perused. No one who reads that section with attention annually can retain for long any serious doubts about the very real value to industry of the associations' research laboratories.

In the earlier part of the document the Industrial Grants Committee discusses a number of matters which came under review in 1960. Amongst other things it became clearer than ever during the year that increasing costs of research are bearing heavily on associations serving small industries. A sum which was adequate ten years or so ago to support a small but nevertheless vigorous association may now prove so insufficient that the association cannot acquire the services of young research workers of suitably high quality or even maintain a satisfactory technical inquiry service. Such a situation does not necessarily mean that the industry is backward. It may be composed of so few firms, each one so small, that to maintain an adequate co-operative research body makes demands too heavy for the individual members to bear. Several possibilities of lightening the burden exist. For example, the file and the cutlery research bodies have acquired "lodger" status in the laboratories of the British Iron and Steel Research Association. Again, two or more small associations in related fields can sometimes find it possible and economical to set up joint laboratories. Then there is the method of working to be adopted initially by the Machine tool industry and for civil engineering of appointing a directing committee or council and a research director or secretary and assigning all actual research to existing laboratories at universities and elsewhere. Nevertheless the overall problem still remains.

EXPORT MARKETS GUIDE

Once again British industry is being assailed with earnest exhortations to increase its exports. Some firms may reflect, sadly, that very little is being done to offer positive inducements to exporters. Others interested, but not yet active in exports, may very well be wondering how they should set about the operation. Fortunately such firms can call upon some useful aids which will provide the sort of background information which should help them in assessing their export prospects. In particular there is the "LSM Export Guide" which was formerly compiled and published by the Export and Marketing Unit of The General Electric Company Ltd. and now, beginning with the July issue, appears under the auspices of the London School of Marketing Ltd.

It will be recalled that the G.E.C. Export Guide, a quarterly publication, was started nearly five years ago and since then its circulation has risen from 3,500 to 15,000 copies. The main information it provides is in the form of a colour-coded chart, or "grid," which forecasts the prospects for thirty-six product groups of British exports to thirty-four countries. For example, the July issue of the Guide shows that the outlook for the third quarter of 1961 is "good" in nineteen countries, "improving" in three, "unchanged" (compared with the second quarter) in four, "deteriorating" in six and "bad" in two.

Although the change in the sponsorship of the Guide foreshadows some expansion of its contents, the intention is to preserve the three essential components — the leading articles, the "grid" and the market reports. Naturally the editorial committee of the Guide has some ideas about the ways of enhancing its contents. But it is refreshing to find that the committee is seeking confirmation of these ideas and is therefore sending a questionnaire with the current issue to find out what sort of information its readers want. Apart from prices and delivery dates, which are more or less under a manufacturer's control, the main factors that influence export performance are the possession of reliable information about changing markets and the application of sound marketing methods. It is here that the Export Guide, developed to meet the specific needs of its users, has a promising rôle to play.

TRANSLATION BY MACHINE

Most of us have wondered at some time how the "unseen" translation got its name, for this form of scholastic exercise always seemed only too painfully visible. Clues to its content were meagre, being confined usually to a title composed on the lines of the kind of newspaper placard which makes "England in Danger" serve equally for a crisis on the cricket field or a call to arms. The idea of a translating machine seemed attractive but no more than an idle dream. It is still a dream compared with such comparative commonplaces as artificial satellites and rocket travel in space, both of which share with the translating machine a common origin in the pages of the cheaper kinds of schoolboy fiction. Now, however, the dream is being brought nearer to reality by the First International Conference on Machine Translation of Languages and Applied Language Analysis, which has been organised by the National Physical Laboratory, and will be held at Teddington from September 5 to 8. As in most operations to be performed by computer techniques, preparation of the material accounts for much of the labour. Once the computer has been stocked with its word roots and endings, however, it can recognise them again and extract the proper equivalents from its ferrite core matrices or thin magnetic films in considerably fewer milliseconds than it takes to turn the pages of a dictionary. The resulting translation is likely to be serviceable rather than elegant. One imagined something rather like the speech of Frankenstein's monster, and we are thinking of the uncouth creature of the cinema rather than Mrs. Shelley's original creation, whose refinement and delicacy of expression were a bitter disappointment to us when we first obeyed the injunction to "see the film and read the book." It is possible that by this unvarnished approach the machine may even reveal what the author means. It might then find application in the diplomatic world, where at present, particularly at times of international crisis, translation of a note is followed by a period of "study by Foreign Office experts" before its contents are made known. Since machine translation will be used primarily on the works of technical authors, one hopes that the authors will know what they mean, and that this meaning may be read at once in, rather than between, the lines produced by the high-speed printer. Some of the subjects of the conference papers are intriguing. Is "Random Generation of English Sentences" concerned with the writing of editorial articles in a heat wave? And what is the meaning of "On the Semantical Interpretation of Linguistic Entities that Function Structurally"? Such terms give common speech a new-found dignity like that which Monsieur Jourdain discovered when he learned that all his life he had been speaking prose. After this we read with relief, albeit with surprise (considering the nature of the event), that "A staff of interpreters will be present during the Conference."

The Engineer—100 Years Ago (JULY 19, 1861).

"THE ROYAL AGRICULTURAL SOCIETY.
THE MEETING AT LEEDS"

"One little engine, of two or three mule power, made by somebody in Newton-le-Willows, stood in a corner in disgrace. It had but one stay-bolt in the middle of each side of its fire-box, and we were further informed that it had no stay-bars on the crown-plate! We need not say that the initials 'C.E.A.' in approving chalk script, were missing on its furnace-end, Mr. Amos having a particularly sharp eye for all such shaky specimens of boiler-making. The pressure to which most of the engines were limited was 30 lb, but we were told that certain engines which were pointed out to us were carrying not less than 80 lb. This might have been, and probably was, very improper under the circumstances, but we should not, after all, have much confidence in a locomotive boiler which would not work safely up to 100 lb to the square inch. The cylindrical part ought indeed to be perfectly safe at that pressure, and the fire-box needs only a sufficient number of stays to be equally strong. Cast iron stay-bars, once so common, are seldom to be found now-a-days, and there is no good reason why the economy of high pressures may not soon be realised on the farm. As a precaution against the recklessness of the attendants, lock-up safety valves are being already adopted, and in Mr. Aveling's engines these are so constructed as to defy tampering."

Off-the-Road Locomotion

By R. M. OGORKIEWICZ, M.Sc. (Eng.), A.M.I.Mech.E.

No. III—(*Concluded from page 62, July 14*)

The First International Conference on the Mechanics of Soil-Vehicle Systems held last month in Italy covered a wide range of subjects related to land locomotion. Several of its papers were reviewed in the first two parts of this series, and the concluding part of the review, which follows, is concerned chiefly with new vehicles and components.

SEVERAL of the papers presented at the Conference on the Mechanics of Soil-Vehicle Systems dealt specifically with problems related to wheels and tyres. Those of particular interest referred to measurements of forces and deformations which occur when wheels roll over soft surfaces. A considerable amount of work has already been done in this field but much more remains to be done, particularly on the important problem of stress distribution at the tyre-ground interface, and on systematising the information obtained about the interaction between wheels or tyres and the soil.

Apart from the paper by Janosi, mentioned in the second part of this review,* which outlined the work accomplished at the Land Locomotion Laboratory of the U.S. Army Ordnance Tank Automotive Command, other interesting work in this field was reported, among others, by E. T. Vincent, of the University of Michigan, in "Pressure Distribution on and Flow of Sand past a Rigid Wheel." The author noted that when a rigid wheel rolls in fine dry sand with considerable sinkage, the sand is displaced upwards ahead and to the sides of the wheel, forming a bow wave, and then falling into the rut behind the wheel. Thus, the motion of a wheel in sand is accompanied by a flow process, as well as compaction, which alone is insufficient to account for the sinkage of a wheel in sand.

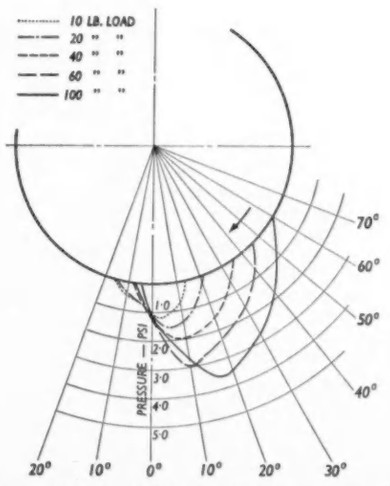


Fig. 1—Variation of loaded area and pressure under centre of wheel, 12·5in outside diameter and 6·5in wide.

In fact, he concluded that, except for lightly loaded wheels with small sinkage, compaction effects were small and the sand flow predominated. Work which led to this conclusion included measurements of pressures at the wheel-sand interface by means of a small pressure transducer consisting of a ¼in diameter plunger fitted into the surface of the wheel and attached to a differential transformer with appropriate circuit whose output gave a trace proportional to the variation of the load on the plunger. Results obtained at the face centre of a 12½in diameter, 6½in wide wheel are shown in Fig. 1; they illustrate a change in the stress pattern between the light, 10 lb and 20 lb loads, when the soil might be considered to behave as an elastic medium, and the heavier loads when the soil no longer appears elastic to any great extent.

Behaviour of wheels in purely cohesive soil was reported by F. L. Uffelmann, of the Fighting Vehicles Research and Development Establishment. In this case a simple compaction theory based on plastic deformation without recovery, i.e. rut formation equal to the instantaneous sinkage, and uniform normal pressure over the arc of wheel-soil contact, gave reasonable agreement with experimental observations at small sinkage. Simple theory also gave acceptable results for the traction available from the wheel rim and the additional contribution of ridged side walls and of spuds. The experiments were performed with 54in wheels 12in, 18in and 24in wide and the results suggested the possibility of a 5ft diameter wheel with a rigid 1½ft wide rim, ridged side plates and self-injecting spuds which would be capable of carrying a load of 3 tons to 5 tons off the road. Such a wheel would be resilient by means of rubber pads between the rim and the hub and would have cavity cushion tyres in segments around the rim for hard ground running.

A related development of a "Forced-Slip Wheel and Track Tester" was described by A. R. Reece and B. M. D. Willis, of King's College, University of Durham. This is a special purpose machine for field measurements of tractive effort, rolling resistance and slip based on the forced slip principle, in which the test wheel, or track, is obliged to rotate at a controlled slip by the unwinding of a rope from a drum which is geared to the wheel under test. The input torque and output thrust are simply measured as they are a function of the forces exerted by the towing tractor and the cable, which is anchored to the ground, and the whole apparatus has the virtue of simplicity and low cost.

At the other extreme in elaboration one may place the test equipment available at the U.S. Army Engineer Waterways Experiment Station and described by W. J. Turbull and D.R. Freitag in "Influence of Soil Factors and Tyre Geometry on the Performance of Pneumatic Tyres in Sand." The equipment is based on a soil bin, which can be built up to a length of 165ft, and a dynamometer carriage which travels on carefully aligned rails and which is linked to the wheel under test. The attachment is such that the wheel can be loaded and powered and yet be free to move up or down as the soil conditions dictate; vertical loads of up to 3000 lb may be applied and the dimensions of the apparatus permit the testing of wheels up to 32in diameter and 16in wide. Normal test procedure consists of towing the carriage and with it the wheel which is being tested at a velocity which increases linearly to a maximum at the mid-distance along the soil bin and then decreases, while the speed of rotation of the wheel is held constant. In this way a complete drawbar pull *v* slip curve is obtained in each pass. Typical curves of drawbar pull and torque *v* slip are shown in Fig. 2, where three points of particular interest are also marked: the zero torque or towed point, the zero drawbar pull or self-propelled point, and the maximum drawbar pull point.

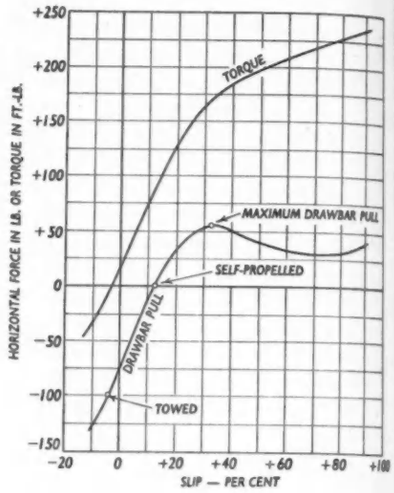


Fig. 2—Typical curves of drawbar pull and torque *v* slip

Initial tests had been performed with three different sizes of tyres of approximately the same overall diameter and without a tread, to eliminate the effect of tread pattern which is to be studied later. Test results, based largely on 4·50–18 tyres, indicated that the various aspects of tyre performance can be related to tyre sinkage but the authors stated that none of the existing methods of predicting sinkage was satisfactory. The last comment seems a little surprising in view of the success in predicting wheel performance achieved at the Land Locomotion Laboratory and the University of Michigan, unless an exceptionally high degree of accuracy is expected. There is no doubt, however, that the authors' well instrumented laboratory should produce valuable experimental data on wheel and tyre performance and it is only to be hoped that at some future date they will be able to synthesise their results.

Extensive testing facilities are also available at the National Tillage Laboratory of the U.S. Department of Agriculture, at Auburn, Alabama. They include soil bins 20ft wide and 250ft long and well instrumented dynamometer carriages, which were outlined by G. E. Vandenberg, I. F. Reed and A. W. Cooper in "Evaluating and Improving Performance of Traction Devices." Unfortunately, no results obtained with these elaborate facilities were given, in spite of nearly twenty-five years' experience to which the authors themselves refer.

Walking Machines

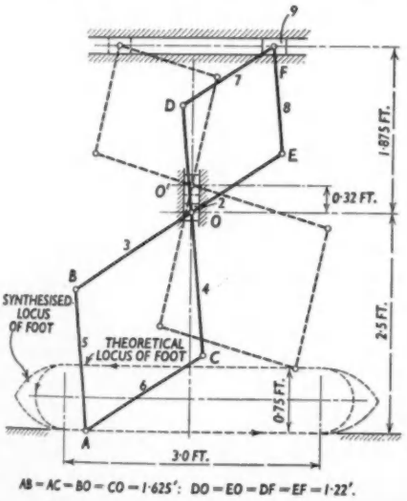
Walking machines have long existed in science-fiction but more recently they have also attracted more serious interest, aroused partly by the hope that under some conditions

* The Engineer, Vol. 212, July 13, 1961, page 59.

their performance might be superior to that of wheeled or tracked vehicles. A consequent investigation sponsored by the Land Locomotion Laboratory was described by J. E. Shigley, of the University of Michigan, in "The Mechanics of Walking Machines." Starting with the requirements of an ideal walking machine, the author established what he considered the most promising locus of the foot as it moves relative to the vehicle. This consists of parallel, horizontal stride and return parts of the cycle, relatively long compared with the height of the step, joined by a semi-circular lift phase and a similar phase during which the foot is lowered. The proposed locus promised to give minimum acceleration and offered the possibility of balancing the inertia forces and torques by properly phasing a number of walking mechanisms on like paths. To make inertia torque reactions on the vehicle small, the author considered that a minimum of sixteen legs was necessary, four at each corner of the vehicle.

Synthesis of a possible mechanical linkage driven by a rotating source of power was based on the Hrones-Nelson method†. It revealed that only a few linkages will generate a path approximating to the desired locus and, in general, the author concluded that none of the walking mechanisms driven by a rotating crank was very satisfactory. None fulfilled the requirement of uniform velocity, unless pairs of non-circular driving gears were used, and none gave a stride which was long compared with the total space required by the mechanism. Moreover, further analysis revealed that, while it was possible in several cases to balance the inertia torques, it was not possible to balance the inertia forces. In consequence, mechanically operated walking machines could only be operated at low speeds but, in view of the infinite number of possible solutions, the author did not rule out the possibility of finding a mechanism which could be balanced.

In the meantime, the limitations of



AB = AC = BO = CO = 1·625′; DO = EO = DF = EF = 1·22′.

Fig. 3—The pantograph mechanism for a walking machine.

mechanically operated machines led him to consider hydraulic operation with two cylinders per leg. One of the two hydraulic cylinders would be used for driving and the other for lifting, and by suitably programming the flow to them the foot could be made to generate the desired locus. Further, to make the lift and driving motions independent of each other, a pantograph mechanism shown in Fig. 3 was adopted in which the centre O was driven up and down by the lift cylinder while a second cylinder drove the slider 9 in the horizontal direction. With this arrangement a single flow programme is sufficient for each cylinder, regardless of the values set for stride or lift, and using a minimum of sixteen legs it is possible to balance the inertia forces and torques.

A similar if less searching investigation has been carried out in Italy by S. Muratori, with the object of devising a mechanical horse which could be used in undeveloped areas on trails or mountain paths. In this case a four-legged machine was considered feasible, possibly because only slow speed operation was envisaged, but it is interesting to note that, as in the above-mentioned paper, hydraulic actuation of the leg in stride was also suggested, with hydraulic or mechanical control of foot lift.

Another scheme has been investigated at the Munich Technical College and reported by H. von Sybel and F. Grose-Scharman in their paper "On Increasing the Tractive Effort of Off-the-Road Vehicles." In this case the vehicle was wheeled but the wheels were mounted on arms which could be swung to and fro about their pivots, as indicated in Fig. 4, which shows a six-wheeled version.

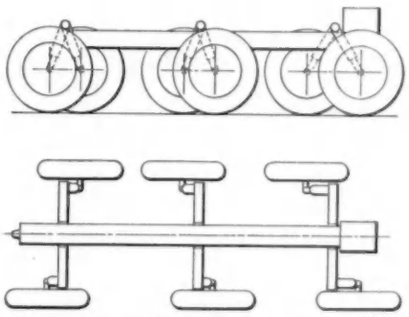


Fig. 4—Diagrammatic arrangement of a six-wheeled walking machine.

With such an arrangement motion of the vehicle could be obtained by alternately braking some of the wheels and pushing the vehicle against them by means of a suitable hydraulic mechanism while other wheels rolled forward under little or no load. In this way advantage could be taken of the fact that greater thrust can be obtained with a stationary wheel than a rotating one, and the system was suggested for use under particularly difficult terrain conditions.

All three investigations indicated that any walking machine would be relatively complex and none showed to what extent their overall performance would be better than that of other vehicles. It is difficult, therefore, to assess whether the investigations point to useful vehicles or whether they are merely an exercise in the theory of machines.

Pneumatic Tracks

In addition to the technical sessions, one practical demonstration also took place during the course of the Conference at the Regional Airport of Aosta. Its subjects were an aircraft with pneumatic tracked landing gear and tractors fitted with pneumatic and roller tracks, all developed in Italy by G. Bonmartini.

The pneumatic tubular track has been under development since 1949, when the first one was made by Bonmartini in collaboration with the Superga company of the Pirelli group. Its first aircraft application was in a Piper light aircraft and the subsequent use of the Bonmartini 2-550-III pneumatic track landing gear in the more modern Piper 18A gained for it in 1959 the approval of the Registro Aeronautico Italiano, the Italian air registration authority. During the trials which led to the approval certificate, the aircraft executed 147 take-offs and landings on grounds such as meadows with ditches up to 12in or 16in wide, cultivated fields with surface depressions not more than 6in deep and 20in wide, and sandy beaches. The same type of aircraft, used for agricultural insecticide spraying and shown in Fig. 5, was demonstrated at the Aosta airfield where it too successfully crossed small ditches which would have been disastrous for aircraft with the normal single wheel landing gear.

The pneumatic track itself is essentially an air-inflated tubular tyre with a casing made up of two nylon or rayon plies secured to two steel bead cables, one on each side of the tube. The plies are placed at 85 deg. to the cables and a natural rubber compound is used for the side walls and the tread. The track is made in two sizes, 150×3740 and 110×3130 with nylon and rayon plies respectively, the weight of one track of the first kind being around 24 lb to 26 lb and of the second 15 lb to 17 lb; in both cases the operating pressure is 35·5 lb per square inch. The track is intended to be used with bogie wheels having a diameter three times its own and so shaped that the bead cables run very close to the wheel rim, as illustrated in Fig. 6, which shows the two-wheel 2-550-III landing gear used with the Piper 18A aircraft. The inner surface of the track is lubricated with castor oil by means of a small pump driven off one of the wheels, and the track gear has been designed for a static load of 1100 lb to 1300 lb. During the rough ground approval trials the total

Fig. 5—Piper light aircraft with the Bonmartini track taxying across a ploughed field

† Hrones, J. A., and Nelson, G. L., "*Analysis of the Four-Bar Linkage*," Wiley, New York, 1951.

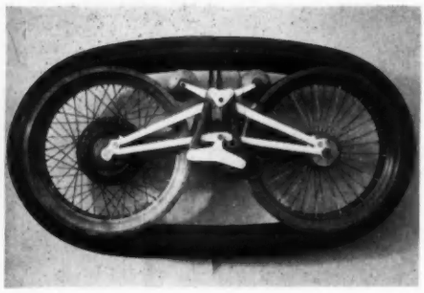


Fig. 6—Aircraft landing gear with the Bonmartini pneumatic track

weight of the Piper aircraft was 1800 lb and maximum vertical and horizontal accelerations of 2·5*g* and 2*g* respectively were recorded. The heaviest aircraft in which this type of landing gear has been tried so far appears to be the Dornier Do. 27, which weighed 3340 lb when tested in 1958.

The attractions of the pneumatic track landing gear for aircraft which have to operate off unprepared grounds are fairly obvious, for it can distribute their weight over a larger area and thus enable them to traverse soft surfaces. In connection with this, it is said that the track gear can be used where a surface pressure of 5½ lb per square inch does not produce a penetration of more than 2in to 2½in, i.e. not more than the radius of the track tube. This type of landing gear has the advantage of reduced frontal area, and consequently lower drag in the air and smaller bulldozing resistance on the ground, over the wide single low-pressure tyre type of landing gear tried on some light aircraft for soft ground operation, and it has the further advantage over single wheel landing gears of being able to span ditches and similar obstacles, as already indicated. At the same time, it has the advantage of far greater resilience over the endless-rubber-band track used experimentally on some heavy aircraft.

Application of the pneumatic track has now been extended to tractors, as indicated in Fig. 7, which shows a Lombardini Castoro light tractor demonstrated at Aosta. The track drive of this experimental vehicle relies on friction between bars connecting the flanges of the rear driving wheels, which imposes limitations on traction, but the pneumatic track has undoubted agricultural possibilities, particularly where a minimum disturbance of the soil is important ; in addition to tractor applications, it could also be used to advantage in some cases with trailers.

Bonmartini has also developed another and entirely different type of track for tractors and tracked trailers, shown in Fig. 8. This is more conventional in that it consists of pin-jointed track links, but each link has two rubber-faced rollers free to rotate about pins set in the links at a small angle to the longitudinal axis of the vehicle. As a result, resistance to lateral track movement is greatly reduced and a smaller moment is necessary to turn the tractor, on hard surfaces at any rate. On soft ground, however, where considerable track sinkage takes place, the rollers lose their advantage and the track could not be used to design vehicles with a greater length to width ratio because they would be as unsteerable in soft ground as similar vehicles with conventional tracks. The most fruitful field of application of the roller track would appear to be in tractors which have to operate frequently on roads and which they could then do without the usual tearing up of the road surfaces when steering.

Articulated Tracklayers

Limitations imposed on the length-to-width ratio of tracked vehicles by conventional steering methods have led to a significant revival of interest in articulated track vehicles, particularly in the United States and Canada. The consequent developments were outlined in *The Steering of Tracked Vehicles by Articulation*, by C. J. Nuttall, of Wilson, Nuttall, Raimond Engineers, Inc., a company which has constructed several such vehicles since the mid-fifties. As the author pointed out, with conventional tracked vehicles the moment necessary to steer the vehicle is generated at the ground by reducing the net longitudinal thrust of one track and, if possible, increasing that of the other. Where the soil is already stressed close to failure, an increase in thrust is not possible and steering is accompanied by a reduction in the total forward thrust. In soft soil this may lead to a complete immobilisation of the vehicle, and it is interesting to note that the Ministry of Supply committee which investigated the bogging down of tanks at the end of the 1939–45 war reported that this occurred most frequently when tanks were attempting to steer.

Difficulties associated with conventional steering methods may be eliminated by using articulated vehicles, which may be made to follow a curved path by changing the attitude of one half of the vehicle relative to the other in the steering plane. Three main types of articulated vehicle configurations, which are in use today, are shown diagrammatically in Fig. 9 ; the fourth, which is

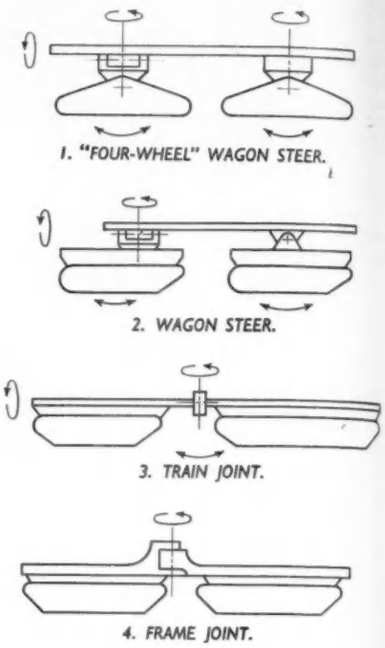
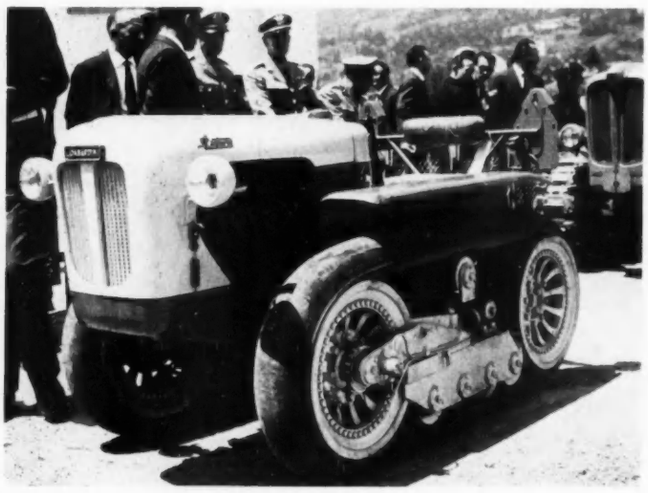
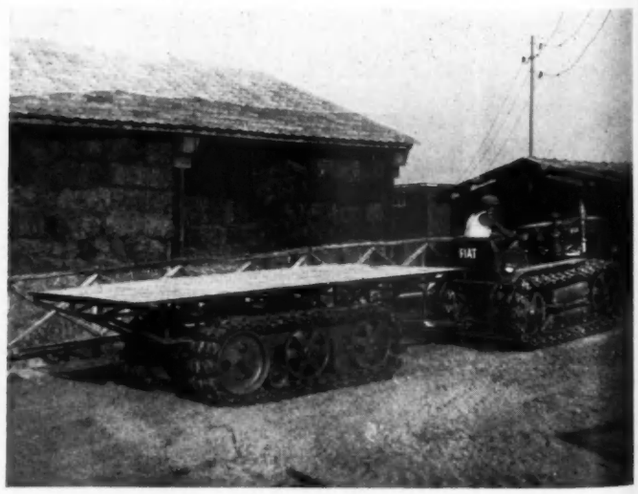


Fig. 9—Main types of articulated vehicle configurations

attributed to Bekker, has not been tried so far and the author considers that its ride advantages are offset by greater component loading. Instead, he suggested that the third type fitted with a heavy damper across the joint in the pitching plane offered a more promising compromise.

Judging by his review of developments which preceded present-day vehicles, the author knew of B. J. Diplock, who pioneered articulated tracked vehicles in this country shortly before the 1914–18 war, but appeared unaware of experiments made during the conflict and again during the early 'thirties. In view of the ignorance about the early history of articulated vehicles, even among those who have studied them for many years, it may be worth noting that Diplock's first articulated tracked vehicle was exhibited at Olympia in 1913 and was fully described





Figs. 7 and 8 (Left)—Lombardini Castoro tractor with the Bonmartini pneumatic track : the track lubricating pump can be seen at the front wheel. (Right)—Fiat 25C tractor and trailer with the Bonmartini roller track

on these pages at the time.‡ The present revival of interest started, as described by the author, during the late 'forties with the construction of the Tucker "Sno-Cat" and Bekker's work on models. The four-track "Sno-Cat" was evolved from experience with several small half-track and half-ski machines and has been used since on some scale for over-snow operation. Among others, four "Sno-Cats" were used by the 1957–58 British Trans-Antarctic Expedition. Another pioneer vehicle was the small belly-less "Rat" evolved by the Canadian Directorate of Vehicle Development in 1955–56. Leading particulars of these and other more recent vehicles are listed in the following table.

General Characteristics of Current Articulated Tracked Vehicles

Vehicle	Manufacturer	Date of introduction	Type of layout[1]	Gross vehicle weight lb	Net payload lb	Payload to vehicle weight ratio	Overall length, ft	Overall width, ft	Installed horsepower	Maximum speed m.p.h.	Nominal ground pressure, lb/in²
"Sno-Cat"	Tucker	1949	1	8,400	2,000	0·24	20·0	7·8	140	12	0·9
"Rat"	Canadair	1955	3	2,000	600	0·30	14·5	3·7	35	10	0·5
"Polecat"	WRNE[2]	1957	3	12,000	4,000	0·33	24·4	5·5	140	27	1·9
Transporter	Nodwell	1958	2	57,000	20,000	0·35	39·5	10·0	300	12	2·0
"Musk-Ox"	WRNE	1959	3	90,000	40,000	0·44	48·6	10·0	375	14	3·1
"Cobra"	WRNE	1960	3[3]	27,000	8,000	0·30	42·7	6·6	200	20	2·1[4]
"Polecat" Mk. II ...	WRNE	1960	3[4]	29,000	10,000	0·35	37·5	8·5	195	27	2·3

[1] See Fig. 9.
[2] WRNE = Wilson Nuttall Raimond Engineers.
[3] Three unit vehicle.
[4] With heavy damper in pitching plane.
[5] Spaced-link track.

In general, the performance of articulated tracked vehicles built so far has shown that by abandoning conventional steering methods it is possible to develop longer, narrower vehicles with very low ground pressures, lower resistance to motion, higher drawbar pull to weight ratios and better ride. Some of the gains possible with articulated vehicles have been brought out particularly clearly by the original "Polecat" built in 1957. This vehicle was built by coupling two M29 "Weasel" cargo carriers, which had been the U.S. Army's principal over-snow vehicles, and on trials it produced a drawbar pull equal to 240 per cent that of the "Weasel" and a 40 to 50 per cent increase in the average operating speed. At the same time, the life of the running gear was extended, which the author attributed partly to the elimination of track tension reversals accompanying normal skid-steering. Apart from higher first cost, a disadvantage of the articulated tracked vehicles is their inability to make very sharp or pivot turns, but this is not of paramount importance in several fields of application. One of the latest vehicles, the "Cobra" built between 1958 and 1960 for the U.S. Army Ordnance Tank Automotive Command, has extended the principle of articulated construction from two to three units and there will, in all probability, be considerable further development of this promising class of vehicles.

Lunar Soil

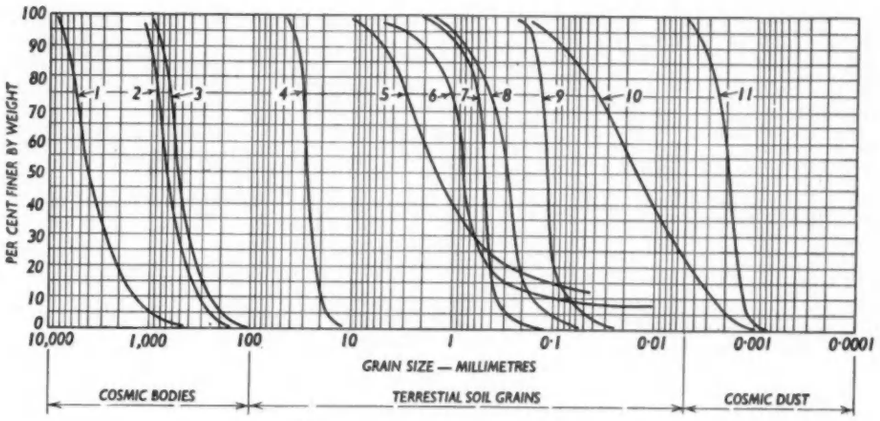
Progress towards exploratory landings on the moon makes it increasingly important to try and predict possible characteristics of the lunar soil, to be able to anticipate some of the problems which might arise. It was particularly interesting, therefore, that the papers presented at the conference included two on lunar soil.

"Some Predictions as to the Possible Nature and Behaviour of the Lunar Soils" by J. A. Ryan, of the Douglas Aircraft Company, listed six environmental factors of importance in relation to the lunar surface. They were the absence of an atmosphere, surface gravitational force roughly one-sixth of that on earth, more extreme surface temperature changes, exposure to greater solar electromagnetic flux, direct exposure to corpuscular radiation, and the absence of protection against the impact of meteorites. So far as the current ideas on the nature of the lunar soil were concerned, there were two principal theories on the origin of the lunar features, namely meteoric impact and defluidisation and volcanic action. Lunar surface material was most likely in powder form and from both the volcanic and meteoric hypotheses the lunar soil would be expected contain much fine grained material or dust. There was, however, wide variance in ideas on the thickness of the soil layer, which has been estimated from 1m or 2m to as much as 1000m or more. In the light of the possible nature of the lunar soil and the environmental effects, the author concluded that lunar soil grains are generally of dust size, comparable to fine sand, and statistically more angular than in terrestial cohesionless soils. The internal friction of lunar soil may be greater or smaller depending on the porosity, which should be higher, and on the occurrence or otherwise of cementation. Porosity may be as great as 90 per cent, in which case there may be serious locomotion problems, but if it is not greater than in cohesionless terrestial soils there should be, in general, no locomotion problems.

The last comment is particularly interesting in relation to such projects as the instrumented exploration vehicles of the "Prospector" series planned by the U.S. National Aeronautics and Space Agency. However, it is probable that by the time such vehicles are landed some more definite information about lunar soil will be available from stationery instrument packages, such as the N.A.S.A. "Surveyor" series, landed on the moon.

N. A. Weil, of the Armour Research Foundation, in his paper on "Probable Soil Conditions on the Moon and Terrestial Planets," also concluded that the lunar surface would be covered by a layer of dust, except for the lunar highlands and crater rims, but considered that the thickness of the layer would vary from the order of centimetres in the marias to several strata kilometres deep in the lunar craters. Such considerations led him to the further conclusion that landings should be made in one of the lunar marias and that further exploration should be made from the marias by tracked vehicles. However, several of his assumptions were challenged by the author of the previous paper, and in view of the probable cohesionless character of the lunar soil one may also question the suggestion that tracked vehicles be used for surface exploration, which might well be done by wheeled vehicles.

An interesting contribution to the discussion was made by M. G. Bekker, who plotted the size distribution of cosmic bodies derived from the observations of H. Brown of the California Institute of Technology, together with grain size distribution of various terrestial soils and the particle size distribution of cosmic dust. The curves are shown in Fig. 10 and their similarity suggests a general law of particle size distribution which, if it could be established, might help to determine the particle size distribution of lunar soil.



1—Asteroids (H. Brown).
2—Iron meteorites (H. Brown).
3—Stone meteorites (H. Brown).
4—Cheril Bank gravel (England).
5—Hong Kong decomposed granite.
6—San Paolo sand (Brazil).
7—Cape Cod sand (U.S.A.).
8—Mason sand (Detroit, U.S.A.).
9—Pumice, grade 0, (U.S.A.).
10—Upper Silesia sand (Poland).
11—Cosmic dust.

Fig. 10—Grain size distribution diagram

‡ "Commercial Motor Vehicle Exhibition," The Engineer, Vol. 116, July 25, 1913, pages 97 and 99.

P.T.F.E. Pump.—A new pump introduced by Associated Electrical Industries, Ltd., has all its working parts made of p.t.f.e. The chemical inertness and imperviousness to corrosive action of p.t.f.e. adapt the pump for handling corrosive fluids or liquids. The pump is of diaphragm design and is self-priming. The diaphragm and all the other p.t.f.e. parts in contact with the liquid are housed in a cast aluminium body which is bolted directly to a capacitor-run a.c. geared motor. The motor gearbox provides a 7 : 1 step-down to give a diaphragm reciprocation speed of 200 cycles per minute. Pump delivery at a 1ft head is 2 litres per minute, and at the maximum working head of 15ft is 1·25 litres per minute; consumption is 50W. A coupler, developed for use with the pump, is of spring-loaded telescopic design and expands to grip the tubing inserted at each of its ends. It enables p.t.f.e. tubing to be joined so that only that material is exposed to fluids travelling in the tubes.

U.K. Atomic Energy Authority

(*Continued from page 50, July 14*)

No. II—RESEARCH ON CONTROLLED THERMONUCLEAR REACTIONS

The seventh annual report of the United Kingdom Atomic Energy Authority published recently covers the year ended March 31, 1961. The following article which is based on the report and supplemented by observations made during a recent visit to the Atomic Energy Research Establishment, Harwell, deals with the current programme of research on controlled thermonuclear reactions. This research work is being transferred, in stages, to the new laboratories of the A.E.R.E. under construction at Culham, Oxfordshire.*

ON a recent press visit to see some of the research work in progress at Harwell we were reminded of the organisational changes which have taken place in the Atomic Energy Research Establishment in the last few years. These evolutionary changes have further clarified the functions and responsibilities of the A.E.R.E. in carrying out fundamental research and a certain amount of basic research on the peaceful uses of nuclear energy, including radioactive isotopes. In this field the main objective, as explained by Dr. F. A. Vick (director of the A.E.R.E. and of the Research Group of the U.K.A.E.A.), is to provide firm scientific and technical foundations upon which much of the future development, design and production work of the Authority will rest. Thus, although the Reactor Group is responsible for the physics and engineering work relating to specific reactor systems, much of the work on the properties of materials to be used in these systems is still done by the A.E.R.E., making full use of its materials testing reactors and research reactors. The Establishment also has special responsibilities in nuclear and solid state physics.

One of the important changes which affects the functions of the A.E.R.E. is the setting up of the new research establishment at Winfrith, Dorset, to do research work, including assessment studies, on reactor systems. Work on the site at Winfrith began in 1957 and the transfer of equipment and staff from the Reactor Division at Harwell took place in 1959 and 1960. The Atomic Energy Establishment, Winfrith, was officially opened in September, 1960 (THE ENGINEER, September 23, 1960) and in April, 1961, it was transferred from the Research Group to the newly-formed Reactor Group of the Authority.

There have also been changes in the responsibility for particle accelerators. In March, 1957, came the announcement of the decision to form the National Institute for Research in Nuclear Science (N.I.R.N.S.) and later in the year the Institute decided to establish its first laboratory (the Rutherford High Energy Laboratory) on the airfield at Harwell, adjoining the A.E.R.E. In March, 1958, the Accelerator Division was formed out of the General Physics Division of the A.E.R.E., to develop particle accelerators. This Accelerator Division was transferred to the N.I.R.N.S. in January, 1961.

Another change, still in its transitional stages, involves the responsibility for controlled thermonuclear reactions. With the expansion of work in this field a Controlled Thermonuclear Reactions Division was formed out of the General Physics Division in March, 1958. In October, 1959, the Atomic Energy Authority announced its intention in concentrating its research in plasma physics and fusion at a new laboratory of the Research Group. This laboratory is being built on the former naval airfield at Culham, Oxfordshire, a few miles east of Abingdon. Although the staff of the C.T.R. Division has been transferred to the new organisation they will continue to work at Harwell until the Culham Laboratory is completed.

The building of Culham Laboratory is being carried out in three phases. The first of these is well advanced and should be finished by the end of this year. It will consist of a large experimental hall adjoining a three-storey block with a wing of small laboratories and offices and services. Work on the second phase of building, having received Treasury approval, will start next month and is due to be completed by the end of 1962. It will include a group of large, medium, and small laboratories, with their local services, and a lecture hall, library and restaurant. The third phase, containing more laboratories and services, should be completed in 1964.

CONTROLLED THERMONUCLEAR REACTIONS

On our recent visit to Harwell we saw some of the work being done by the staff of the Culham Laboratory. Its main purpose, as explained by Dr. J. B. Adams, the director of the Laboratory, is to explore the possibility of using controlled thermonuclear reactions as a source of power. At present the most promising method of controlled release of fusion energy appears to be to heat an ionised gas containing isotopes of hydrogen, up to temperatures of about 100 million deg. in an airtight chamber. At these temperatures the gas is fully ionised and is called plasma. One condition for the fusion reaction to take place is that the plasma must be isolated from the walls of the chamber. Most experiments seek containment by setting up magnetic fields interacting with the electric currents in the plasma.

Although many different configurations of magnetic fields and currents in the plasma have been devised and tested experimentally, most of them have proved, hitherto, to be unstable in some way. Because of the large forces involved and the small inertia of the hot gas, the tendency is for the instability to grow very rapidly, causing failure of the containment before useful amounts of thermonuclear energy have been released. At present the main objective is to concentrate on the problem of containment and by basic research on plasma to study the instabilities in detail.

At Harwell most of the early work was directed at containing and heating a plasma by passing a heavy current through it; interaction with its own magnetic field caused the current-carrying plasma to experience pressure acting towards the axis of the discharge—the so-called "pinch" effect.

The largest pinch device so far attempted is "Zeta," in which deuterium gas is heated and confined by short pulses of very high currents. Despite modifications, involving increased current and an improved vacuum system, the plasma temperature has not reached the expected values. Much recent work on "Zeta" has been of a diagnostic character, aimed at discovering the source of this excessive energy loss. Measurements have been made during discharge pulses, on the variation of magnetic field strength, particle density and various forms of radiation emission. It has now been established that, at the higher gas pressures in use, the main loss is due to radiation from the minute amount of impurity present, whilst at the lower pressures the energy is lost by plasma reaching the walls. The mechanism whereby the plasma crosses the magnetic lines of force in defiance of simple diffusion theory is being investigated.

Containment studies have been extended to several systems quite distinct from the original "pinch" approach. In "Hard-Core" (or "Un-pinch"), containment is achieved by forcing the plasma outwards, rather than inwards as in pinch methods. The stability properties of the two systems are being compared. Experiments are in progress to check the theoretical grounds for expecting a very stable system using "cusp containment," though plasma leakage is possible. A further containment system being tried where the effects of instabilities may be minimised, uses radio-frequency magnetic fields.

Besides studying different containment methods, alternative means of obtaining a hot plasma are being attempted. One approach uses the development of shock waves in the plasma. Another method involves the injection of highly energised charged particles into a containment system from which they should have little prospect of escape, and a "mirror" machine is being built for this study.

At the same time more specific aspects of plasma physics, such as the propagation of disturbances in plasma are being studied. Cross-section measurements, which determine the probability of particle collisions of various kinds, are also being undertaken.

WORK WITH "ZETA"

The original "Zeta" experiment has been considerably modified. The stored energy available for the "pinch" discharge has been increased sixfold by adding two banks of capacitors (1·5MJ and 3MJ energy, arranged in sections of 0·75MJ each) to supplement the original 0·5MJ bank of capacitors. They consist of 8kV capacitors connected in series to work at 24kV, but they can be reconnected to provide a larger capacitance, operated at 8kV for use in a power clamp circuit to inject additional energy when the gas current reaches its peak value. Make, clamp and dump duties are now carried out by ignitrons which have been installed in place of the original air-operated mechanical make-switch. The largest ignitron will handle peak pulse currents of 80,000A at 24kV and the instant of firing can be accurately synchronised with diagnostic equipment.

To match the increased output from the capacitor banks the transformer windings have also been modified. In "Zeta I" the pulse winding was directly on the laminated ring core. To reduce leakage inductance and thus increase the gas current a new pulse winding has been installed: it is in two parts, the inner turns being wound on the transformer core and the outer ones on the torus. The winding has been mechanically strengthened and has been worked for prolonged periods with energy inputs up to 1MJ and, occasionally, 3MJ.

Because the insulated aluminium liner system installed in the torus of "Zeta I"

* "United Kingdom Atomic Energy Authority, Seventh Annual Report. 1960–61." H.M. Stationery Office. Price 5s.

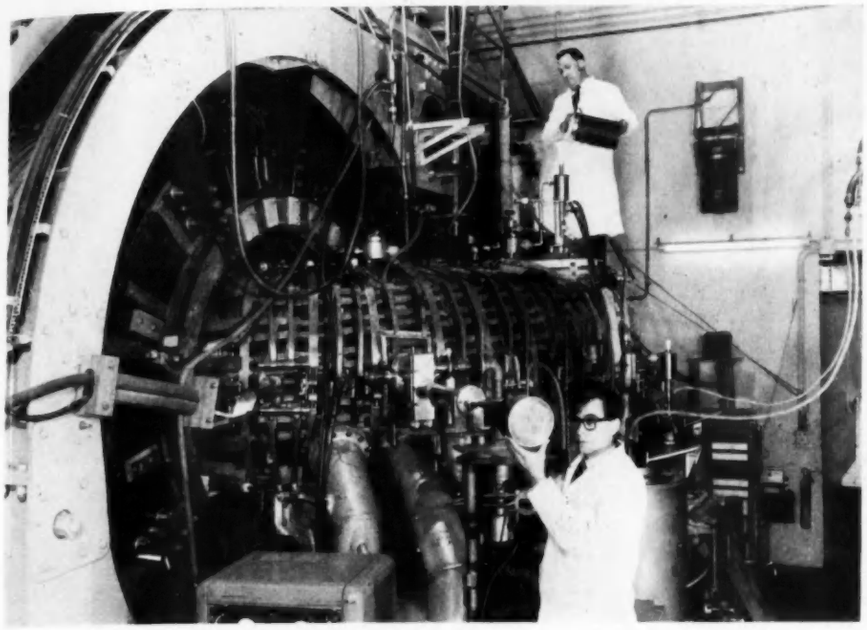


Fig. 1—" Zeta " is being used at Harwell for research work on the formation, containment and heating of plasma. In the foreground a total-radiation probe is being adjusted

has a limited life and required frequent overhauls it was replaced by a corrugated stainless steel liner supported on " Mycalex " insulators, the two halves being electrically connected at the main gaps by rings carrying sprung double contact fingers. Improvements in the sealing of the liner-torus interspace from the main discharge channel, combined with separate pumping of the interspace, allow an increased pressure differential to be maintained. This assists in preventing ionisation of gas in the main gap region (which would cause main gap breakdown) and reduces contaminating atmospheric leaks into the discharge channel.

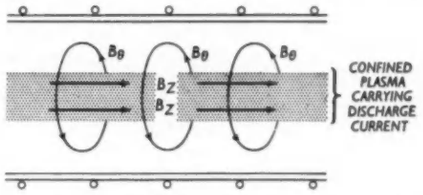
As stated above two definite regimes of energy loss have been established on " Zeta." These regimes are determined principally by the pressure at which the machine is operated. At low pressures ($0{\cdot}5 \times 10^{-3}$mm mercury) the energy is lost by particles ; first by plasma which leaks across the magnetic field, and directly transports energy to the walls ; secondly by fast electrons which are accelerated at the termination of the current pulse and strike the walls. At higher pressures (5×10^{-3}mm mercury), line radiation from impurities is the dominant loss process and under certain operating conditions accounts for the total energy fed into the discharge. Theoretical considerations show that the observed impurity content of one-tenth of 1 per cent can account for the radiation loss. This impurity concentration represents a pressure of $0{\cdot}5\times10^{-6}$mm mercury.

A spectroscopic method has been developed for investigating the containment of the " Zeta " plasma. It has shown that containment is violated by two processes—an escape of hot plasma from the confining system and an injection of atoms from the wall. These processes are measured independently and, in general, the net effect of both is to cause a decrease of plasma density during the " Zeta " pulse. This effect is known as " pump-out." The loss rate increases with the energy input per unit mass of gas, and when the latter is large, most of the energy is carried to the walls by the escaping plasma.

Stabilised Pinch

A great deal of the C.T.R. work at Harwell is concerned with discharge stability. An important condition for hydromagnetic stability is that the current should flow in a thin skin on the surface of the plasma column. In one experiment on the stability of a pinched discharge a capacitor bank supplies a rapidly increasing current of about 200,000A.

The current flows in a cylindrical shell about 4cm thick, that is, one-quarter of the radius of the discharge tube (Fig. 2).



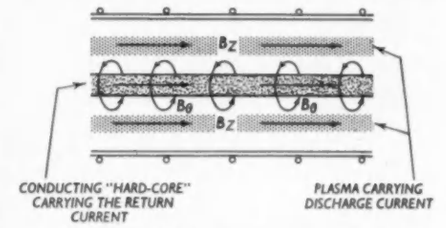
B_θ : Magnetic field caused by discharge current itself. This effectively exerts an inwards pressure on the current-carrying plasma.
B_z : Stabilising magnetic field created by a current passed through the coil wound on the discharge tube. It is trapped in the conducting plasma.

Fig. 2—Stabilised pinch

The magnetic pinch forces cause the discharge channel to pinch away from the walls towards the axis of the tube. Inside the channel is an entrapped axial magnetic field which helps to stabilise the discharge. The stable region does not, however, last for long and after about ten microseconds the channel breaks up, as can be shown by fast photography or magnetic field measurements. The discharge strikes the walls of the tube, and heating of the gas to high temperatures is thereby prevented. Theoretical considerations show that if the current could be made to flow in cylindrical shell which is very thin compared with the radius of the tube its stability might be improved. In practice this condition is very difficult to obtain in an apparatus of these small dimensions, as it requires the attainment of a very rapidly increasing current passing through a gas which has already been heated to a temperature in the region of 100,000 deg. Cent.

Hard-Core System

The hard-core discharge for which the apparatus is now being modified should be more stable than the pinched discharge described. The current in this case (Fig. 3) flows in one direction along an insulated control rod, and in the opposite direction in the gas between the electrodes. The current starts near the central rod, and expands



In this case the B_θ field acts from within the plasma forcing it outwards. A hollow cylinder of plasma results and the B_z field isolates it from the outer walls.

Fig. 3—Hard-core system

outwards due to the repulsive force of oppositely directed currents. Its expansion is stopped before it reaches the outer wall of the tube by an axial magnetic field entrapped between the conducting gas and the outer metal sheath of the tube. In this magnetic field configuration any perturbation of the current channel tends to be suppressed. In contrast with the pinched discharge no limitation on the thickness of the current shell is imposed by theoretical conditions for stability, and a stable discharge should therefore be more easily achieved in this arrangement. Results obtained using short tubes have shown the hard-core discharge to be only slightly more stable than the pinch, but the close proximity of the end electrodes may have influenced this result. A modified hard-core apparatus is, therefore, being built with a tube four times the length of the short tube, so that the stability of the current in a region remote from the electrodes can be studied. Thus it is hoped to make a direct comparison of the pinch and hard core discharges.

The representation of the hard-core system shown in Fig. 3 is purely diagrammatic. Physically the conducting hard core is a copper tube surrounded by a silica sleeve which insulates the tube from the disc-shaped electrodes—one at each end of the system. These circular electrodes close the ends of an outer cylindrical tube of silica to form an enclosure for the discharge system. Outside this enclosure and separated from it is a metal cylinder to act as a former for the solenoid winding which generates the axial magnetic field.

In the new hard-core experiment the discharge-tube will be 10ft long by 1ft diameter with a core of 4in diameter. The capacitor bank, of 126 microfarads, will produce a discharge, controlled by a spark gap, with a maximum current of 250,000A for twenty-five microseconds and the axial magnetic field will be 7000 gauss.

A toroidal version of the hard-core system is being built under contract to U.K.A.E.A. at the research laboratories of A.E.I., Ltd., Aldermaston.

Mirror System

An experimental apparatus is being built at Harwell for the study of new ways of establishing a high-temperature plasma by the direct injection of fast particles into a " magnetic bottle." In the " magnetic bottle " a long, straight magnetic field is bounded at each end by a region of stronger field which is known as a magnetic mirror because it has the property of reflecting charged particles ; it acts like the stopper at the open end of a bottle (Fig. 6). But containment is generally incomplete

Fig. 4 and 5 (Left) Part of the main 3MJ condenser bank for "Zeta." Each of the ignitron switches (e.g. centre foreground) can carry 80,000A. (Right)—Part of the "cusp" experiment showing collector plate and some of the clamp switches

because of leakage of some of the particles in the plasma from the ends of the "magnetic bottle."

In the new experiment it is proposed to achieve long path lengths of the injected particles by space modulation of the magnetic field. The particles, molecular ions, will be injected axially at such a velocity that they will undergo radial acceleration at their own cyclotron frequency because of the modulations in this "corrugated" magnetic field. Further trapping will occur when the molecular ions break up into atomic ions on collision with residual gas atoms. The power supplies for the magnetic field include a battery of 800, 5kW (peak, pulse) cells giving a mean output of 250kW.

This apparatus is at present under construction. In the meantime the mathematical equations defining the motion of a charged particle in the "mirror" magnetic field are being studied with the help of an electronic analogue computer.

Cusp Magnetic Field Experiment

Another magnetic configuration which is being studied is the "cusp" system (Fig. 7). Theoretically the cusp configuration is much less liable to instability than the pinch since in the former system the magnetic field everywhere increases with distance from the plasma. Nevertheless plasma tends to leak out of the cusp apices. In principle, this loss can be made negligible by increasing the size of the apparatus, because the size of the leak does not increase in proportion to the volume of the contained plasma. In practice, however, this proposition is yet untested, for the nature and size of the "hole" are not really known and it is extremely difficult to get the required quantity of hot plasma into the cusped configuration. The size of the "hole" depends on the magnitude of the containing magnetic field and on the temperature of the plasma, but a serious increase might be caused by a variety of complex conditions, e.g. plasma turbulence in the boundary between plasma and field.

Of the various possible ways of establishing plasma in the cusp configuration, that used in the present experiment is to compress a moderately preheated plasma. This is done by increasing the cusp-shaped magnetic field with time. This gives a final plasma, with high density confined by a large magnetic field, which is amenable to a study of the fundamental processes.

In the present experiment preheating to 100,000–200,000 deg. is affected by colliding shock waves. The compression field, which is spindle cusp shaped (i.e. produced by two coils with currents in opposite directions), rises to more than 100 kilogauss in eighteen microseconds and then decays with a time constant of a few hundred microseconds. It is expected that the final plasma will have a temperature of one or two million degrees, and a density of 10^{17} particles per c.c. Containment times are expected to be of the order of 100 microseconds. A major engineering effort has been required on the development of auxiliary apparatus, including a 1MJ capacitor bank to supply the magnetic field excitation; switching arrangements to handle the 1·5MA currents in the coils; and mechanical bracing of the coil structure to withstand the imposed electromagnetic forces of several hundred tons.

In recent months work in this experiment has been concentrated on the early stages of the compression phase and some preliminary information has been obtained. The present objective is to measure the containment time for a wide range of conditions and thus to study the mechanisms which control the "hole" size.

Alfvén Wave Experiment

Experimental and theoretical work has continued at Harwell on Alfvén wave propagation.

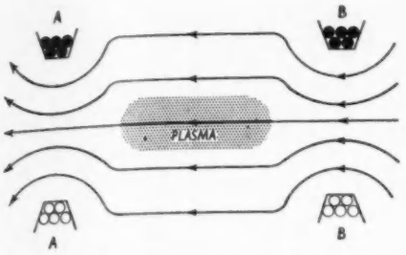
In 1942 Alfvén showed theoretically that local motion of a conducting fluid in a magnetic field can be transferred to the surrounding fluid, and that the state of motion is transmitted as a transverse wave along the direction of the magnetic field. These waves are known as magnetohydrodynamic waves, or Alfvén waves. Alfvén gave the following simple physical picture of magnetohydrodynamic waves:

A magnetic field behaves mechanically as if the lines of force were subject to a tension of $\mu H^2/4\pi$. Also, if the field is trapped within a conducting fluid, then the lines of force have associated with them the density of the fluid. The lines may therefore be considered as material strings having both a tension and a density, and like ordinary strings they may oscillate. Simple dynamics shows that the velocity of propagation of transverse waves along a stretched string is given by:

$$V^2 = \frac{\text{Tension}}{\text{Density}}.$$

Hence, using this analogy, the Alfvén wave velocity should be given by $V_A{}^2 = \mu H^2/4\pi\rho$ where V_A in the Alfvén speed, H is the magnetic field strength, and ρ is the density of the fluid.

This is in fact the same as the expression arrived at by Alfvén using a theoretical analysis based on the equations of magnetohydrodynamics. The velocity quoted above strictly applies only to the case of wave propagation in an incompressible fluid with infinite conductivity, zero viscosity, and no boundaries, but the theory has been extended to allow for the effects of electrical resistance,



In this arrangement the two coils *AA* and *BB* carry currents in the same directions.

Fig. 6—Mirror system

the presence of solid boundaries, and other physical parameters which are important in this experimental work.

The apparatus in use at Harwell consists of a conventional gas discharge tube which provides a partially ionised argon plasma in an axial magnetic field. Oscillatory electric currents, which flow radially between two subsidiary electrodes, generate in the ionised gas local oscillations which, because of the magnetic field, propagate as Alfvén waves along the tube. The waves are detected by magnetic search coils, the velocity being given by the time delay between signals from two coils spaced along the tube and the attenuation by the relative amplitudes of the signals. These measurements show close agreement with the theoretically predicted behaviour of the waves.

Shock-Heated Pinch

The possibilities of using a shock-wave to heat a plasma to the high temperatures needed for a fusion reaction are being studied. In the shock-heated pinch experiment at Harwell a pinch discharge is imploded to produce heat, and, although the energy available is much less than that necessary for fusion, the equipment is useful for basic work on plasma physics.

The main discharge takes place in a cylindrical enclosure between two electrodes 24cm in diameter and 80cm apart. First, a longitudinal magnetic field of 800 gauss is applied, to improve the stability during the final stages of the discharge. Secondly, hydrogen gas in the chamber is ionised by passing 30,000A for about one ten-thousandth of a second. Finally, a pulse of current is passed which rises to over 100,000A in a millionth of a second. The self-magnetic field of this current provides a cylindrically-imploding magnetic " piston," which moves typically at speeds of 50km per second. By measuring this magnetic field and the changes in the longitudinal field, the movement of the plasma can be deduced.

This kind of discharge is particularly suitable for detailed theoretical analysis as the major phenomena are simple and occur too quickly for secondary effects, such as instabilities, to confuse the issue. Comparison between experimental and computed results is leading to a better understanding of the phenomena involved.

High Power Switches

The increase in the scale of C.T.R. experiments during the past four years has necessitated the rapid development of components for the storage and transfer of large quantities of electrical energy. In particular, various kinds of switches have been made for discharging large capacitor banks which are capable of passing pulse currents of 100,000A or greater and of ten microseconds to ten milliseconds duration. Some are simply larger versions of switches already available for similar duties, such as thyratrons, some are modifications of switches which have been used for several years in a.c. power circuits, such as ignitrons, and some are entirely new kinds of switch which have been specially developed.

Because of the short operating times required (typically 0·1 microsecond), mechanical switches cannot be used. Switches for capacitor discharge duty therefore involve the breakdown of gaseous insulation between stationary electrodes and the passage of current by means of an arc discharge. To withstand high voltages the gas in the switch must either be at high pressure (1 atmosphere or above) or at low pressure (10^{-3} to 10^{-8} of an atmosphere). The characteristics of high- and low-pressure switches differ in several respects, and both kinds are being developed.

High-Pressure Switches.—The main advantage of high-pressure switches is the consistency of their static breakdown voltage, thus allowing any voltage up to the normal working voltage to be withstood reliably. The working voltage is varied in any particular switch by varying the gas pressure, keeping the electrodes fixed. A second advantage is that they are capable of rapid operation, triggering times down to 10^{-8} second being possible if the voltage across the switch is close to its normal working voltage.

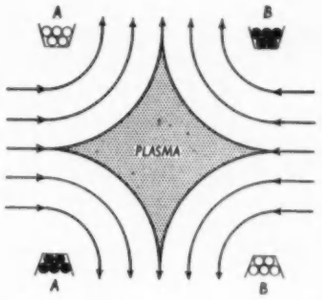
Several kinds of high-pressure switch have been made, the two most usual being the trigatron and the swinging cascade gap. In the trigatron, the voltage is withstood by a single gap between two electrodes, one of which contains a small trigger pin. In the swinging cascade gap the voltage is divided between two gaps using three electrodes with the trigger pin in the central electrode. Either type may be made co-axial or as an asymmetric gap, depending on the working conditions. Co-axial switches have been designed for operation up to 100kV and 260kA and asymmetric switches for use up to 40kV and 100kA.

Low-Pressure Switches.—In low-pressure switches the discharge is more diffuse than in high-pressure switches and therefore higher currents or longer current pulses can be switched without electrode damage. Other advantages are that they may be operated over a very wide voltage range without changing the gas pressure, and that they are generally of lower inductance than high-pressure switches.

The commonest kinds of low-pressure switch are those using a mercury vapour discharge with a mercury pool cathode. Switches of this sort, based on either the mercury arc rectifier or ignitrons, have been developed in conjunction with industrial firms for operation up to 100kV and 100kA. Thyratrons with both thermionic cathodes or mercury pool cathodes have also been used. Various types of plain vacuum gap have been constructed, consisting simply of two metal electrodes in a vacuum vessel, capable of passing currents up to 50kA (or 1MA in special cases).

Materials Research for C.T.R.

Conditions imposed on the walls of the containing vessels used for experiments on plasma can be extremely rigorous, even though the time for which the plasma is heated may only be measured in millionths of a second. At various stages during the heating and confinement of a plasma, the inner surface of the walls of the container may be subjected to intense ion bombardment, electron bombardment, and radiation, chiefly of ultra violet light and soft X-rays. These affects can result in loss of wall material, and consequent contamination of the plasma due to sputtering, evaporation, and chemical and thermal decomposition. The sudden heating



The coils *AA* and *BB* carry currents in opposite directions.

Fig. 7—Cusp system

produces severe mechanical stresses which may lead to the disintegration of the inner surface, or possibly to the complete shattering, of the container. Work is, therefore, being done both by the Culham Laboratories, and by the Metallurgy Division at Harwell, to investigate these effects, so that the most suitable materials for C.T.R. containing vessels may be specified. One aspect of this work is exemplified in the development of a plasma " gun " for projecting a stream of hydrogen plasma at the materials to be investigated.

The material under study is placed in an evacuated container a few inches from the muzzle of the gun, which consists of a concentric electrode arrangement placed at one end of the container. Electrical energy is stored in a small condenser bank, and is fed into the gun by means of a spark-gap switch. A stream of plasma, about 2cm in diameter, is produced and leaves the gun at a velocity of about 5cm per microsecond, giving up 40J of energy per square centimetre to the target in five microseconds. That even such a short time of interaction between a plasma and a surface can produce considerable damage is demonstrated in two ways :

(1) The plasma from the gun is allowed to impinge on a molybdenum foil. This metal has a high strength and a very high melting point, but although the mass of the plasma which strikes it is only a few millionths of a gramme, the impact causes instantaneous melting, tearing and buckling of the foil.

(2) The gun is fired a second time so that the stress of plasma passes through the hole already produced in the foil, and spreads out on to a glass plate some 12in from the gun. The resulting erosion of the surface of the plate is demonstrated by the almost complete disappearance from it of a gold film previously deposited on the surface. Photomicrographs of typical surface damage produced by plasma bombardment show that because the sudden heating of the surface is of such short duration that only a very thin layer is affected. The surface is broken up into a mosaic of fine cracks which penetrate to a depth of (typically) one thousandth of an inch, and then tend to turn over and run parallel with the surface. This tendency causes flaking and exposure of fresh material to the plasma and can result in an important loss of wall material from C.T.R. containing vessels.

Minute nodules have also been observed to form on the surface of certain ceramics such as alumina and electrical porcelain under plasma bombardment. Their formation is undesirable because the tips of the nodules can attain a much higher temperature than that of a smooth surface, with the result that more thermal decomposition and evaporation of impurities into the plasma can take place. They also tend to break away from the surface and thus increase the rate of loss of wall material.

(To be concluded)

Radio Techniques and Space Research

This year the biannual convention of the British Institution of Radio Engineers discussed some forty papers on applications of radio in space research. The sessions covered satellite engineering, launching, extra-terrestrial measurements and radio astronomy as well as the uses of satellites for communications and navigation. Our summaries of papers below are selected from those dealing with the two subjects last-named in view of the plans announced by the Post Office for participation in space communications experiments, to which reference was made in our July 14 issue.

THE background to the present situation of world communications was given in a paper presented to the British Institution of Radio Engineers 1961 convention by Messrs. M. Telford and G. A. Isted, both of Marconi's Wireless Telegraph Company, Ltd. They thought most communication engineers would agree that not only had our present radio system reached saturation, but also, being so dependent on natural conditions, that it could not provide the high-quality service which the user of to-day demanded. At the best, the typical long-distance radio telephone circuit was narrow-band by modern standards. It was not capable of carrying more than four single-sideband telephone channels and was generally out of action for quite a substantial proportion of the time. Although the coming of the transoceanic telephone cable had transformed the situation on several major routes, there seemed little doubt that we had reached the cross-roads in communication and nothing short of a revolutionary change in technique would allow us to meet the needs of the future.

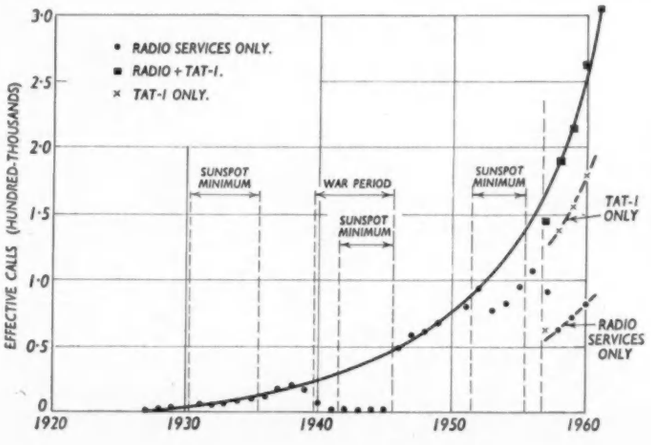
The authors proceeded to discuss methods by which the expansion of communication in the foreseeable future might be forecast. One method was to plot long-distance traffic and to study its growth, and as an example [the [accompanying diagram was shown, giving the yearly numbers of U.K.-originated calls carried over h.f. radio systems terminating outside Europe, beginning in 1927. The later data included calls over the first transatlantic cable (TAT-1). The regularity of the curve drawn through the points in periods where natural growth was unimpaired by influences outside engineering control was of great interest, as was the rapidity of return to this curve when the external restraints disappeared. There were two main irregularities—one obviously due to the 1939–45 war and the second from 1952–57. A sunspot minimum lasted from about mid-1951 to mid-1955 and it was hardly to be doubted that its deleterious effect on radio-communications was a major cause of the 1952–57 " kink."

A further but related cause was very probably the sheer inadequacy (in quantity as well as quality) of the North Atlantic radio service to cope with the traffic need on this route. Subsequent to the installation of TAT-1 the number of North Atlantic calls from the U.K. in the year ended March 31, 1960, was three times as great as in the year ended March 31, 1956, while international radio calls originated in these islands had increased by about 65 per cent only. There was little sign of slackening in North Atlantic traffic growth, and waiting times of more than an hour during the busy period were common, despite the fact that the number of circuits available on the cable had been more than doubled since its opening, by the introduction of 3 kc/s spaced channelling and the T.A.S.I. (time assignment speech interpolation) system.

On the h.f. radio services, connection times of two hours were no rarity, despite the high skill and good judgment of the operators. Calls originated in the U.K. via the radio services, since they began, had only totalled about 1,250,000 or roughly one per forty of the population. It did not seem likely that more than one in ten of these would be private calls—say approximately one call per 30,000 adults per year on average. This estimate was probably generous. How much then were we deterred by high cost, low quality and long waiting times ? What would happen if the cost could be divided by two or four, the quality brought up to that of a good inland trunk call, and the waiting time made to disappear ?

The authors then compared intercontinental telephone traffic and facilities with other classes of telephony, such as internal calls on national systems ; they concluded that present facilities for long-distance telephone communication were, in the majority of cases, utterly inadequate for the needs of the world to-day and to-morrow. Their third method of analysis was based on finding out statistically what had happened to other forms of communication. It was interesting to look at railway growth, 1862–1913. Only about 80 per cent more line was laid, yet the number of passengers increased about 700 per cent. If we could assume that by 1980, say, long-distance telephone calls of the type under consideration would have increased to 200 million world-wide, and that the system carrying them would be meeting the 1980 need, it would not necessarily follow that the requirement in the year 2030 would be to carry 1600 million calls, but it might be a fair guess, assuming that some totally different form of telecommunication was not in existence and that peace and prosperity remained with us for the whole period.

To attempt to plan so far ahead might be unrealistic, however, in view of the rapid growth in techniques. We must make as sure as we could that the foundations we laid in the next ten years would be capable of expansion and adaptation to increasing and changing techniques and needs, but the fact that we could not plan with any assurance for later than the year 2000, if as far, should not be allowed to hold us back. If we had to " go it alone " it was probable that we could set up a very effective satellite communications system to all parts of the world for a first cost not exceeding £1000 million, including development costs for the rocket launchers. This represented about two television sets per wage earner, or half the country's annual budget !



Intercontinental telephone traffic originating in the United Kingdom for countries outside Europe (British P.O. data). Traffic by the first transatlantic telephone cable (TAT-1) is included

Satellite Communication Engineering

A paper by W. L. Wright and S. A. W. Jolliffe, of Marconi's Wireless Telegraph Company, Ltd., entitled " Optimum System Engineering for Satellite Communication Links," opened by reviewing forms of satellite and orbit parameters. The passive satellite repeater, because of its inherent simplicity as a large metallised reflecting sphere, was extremely reliable, but large tracking aerials and powerful transmitters were necessary, even over moderate distances, to provide a workable signal-to-noise ratio. The cost of receiving site equipment would preclude its use for general broadcast application, although the military would no doubt envisage its use, simply because it was more difficult to jam.

In the active satellite system a radio repeater captured the signal, amplified it, and retransmitted it to another point on the earth.

Relay satellites could be further classified as high and low orbit systems. One high orbit system utilised stationary or synchronous satellites located at an altitude of 22,400 miles above the earth. Virtually complete world coverage from three satellites was possible with this system. A large number of low-level satellites, distributed in many different orbits, was necessary to ensure having at least one satellite in simultaneous view of ground station pairs when the low orbit system was used. This problem could be alleviated to some extent by the ability to predict all orbits and plan for " outages."

The stationary satellite appeared an attractive solution to global communications but four basic problems could limit its general use. They were : time delay, stability, r.f. power limitation, and spectrum occupancy. The time delay between a message relayed via a stationary satellite and the earliest reply was 0·48 second, which could, under certain circumstances, result in the blocking of conversation and was therefore stated to be an embarrassment to the user. Since the use of wideband modulation techniques might be more necessary in the case of the

stationary satellite than in that of the low orbit repeater, the required frequency spectrum might well be unavailable.

In one type of low-level active system the signals to be relayed were received as the satellite passed over one ground transmitter and stored until the addressee receiving station was within sight of the satellite. Such a communication link, known as the "Courier" system, was no doubt useful for the conveyance of low-priority information, but it was believed that the greatest demand was for high reliability, real-time, two-way circuits.

The satellite orbit characteristics, height above earth, the period, the shape, and the inclination of the orbit to the equatorial plane of the earth, determined the points on the earth's surface which might be linked, and the period of time the satellite was mutually visible to both stations. The stationary satellite in an equatorial orbit appeared fixed over a particular point on the equator and was thus capable of providing continuous service between any two points on the earth's surface from which the satellite was visible.

To provide continuous communication between any two ground points by means of non-sychronous satellites it would be necessary to use a number of satellites, the number required for any given service being considerably less if their relative positions were maintained. A satellite which maintained its position relative to other satellites was called "station-keeping," and this could be accomplished only by continual correction of orbit by thrust apparatus within the satellite.

A system using satellites in elliptical orbit might be used instead of a system using circular orbits. Both might be classified as low-level systems. Whereas the attitude stabilisation of a satellite in an elliptical orbit required more power than for a satellite in a circular orbit, it might be possible to achieve world-wide coverage with elliptically orbiting satellites using less total launching energy than that required for satellites in circular orbit.

If a system was required to serve ground stations within a restricted range of latitudes, this could be accomplished more economically with elliptical than with circular orbits. If the inclination was chosen to be 63·4 deg. the latitude of the apogee was constant, and could be chosen to give the coverage required. Since the satellite moved more rapidly near its perigee, it spent most of its time at great heights near the desired latitude. If the specific service required were to link North America with Europe, elliptical orbit satellites might well be the economic solution.

The paper proceeded to consider the optimum frequency for communication between a satellite and an earth station. It was necessary to optimise all the parameters in the satellite-to-ground link because of the very limited power available in the satellite. This limitation, which was unlikely to be substantially improved in the near future, placed special emphasis on transmitter efficiency (d.c. to r.f.). Transistors had a high potential reliability but could only provide the order of a watt of r.f. power up to a frequency of a few hundred megacycles. It appeared unlikely that reasonable powers at much higher frequencies would be available from transistors in the next few years.

The high acceleration and shock encountered in the satellite launch phase was a most critical test of the reliability of thermonic valves. Triodes with close electrode spacings, and travelling wave tubes, could provide a workable output, but adequate cooling was essential in both cases. However, for the future, travelling wave tubes offered the greatest possibilities especially at frequencies of 1000 to 5000 Mc/s. Primary power limitations, in the next few years, would limit the r.f. output to the order of a few watts.

Since the first communication satellites would probably attempt to radiate isotropically and employ following ground aerials, the overall attenuation would be substantially independent of frequency. Under these conditions the point of total minimum noise determined the frequency which would provide the maximum signal-to-noise ratio ; due to the development of very low-noise amplifiers, this was limited by natural noise and occurred in the 1000 to 5000 Mc/s spectrum. In order to minimise the periodic degradation of a high-capacity system by galactic and solar noise, the use of the higher end of the spectrum was indicated. Within the band 1000 to 5000 Mc/s the choice of frequency would be mainly based on equipment engineering factors and the availability of frequencies. Aerials capable of radiating isotropically and high efficiency transmitters were more likely to be available at the low frequencies.

Modulation systems were also considered in the paper, and numerous advantages of pulse code modulation were underlined. Experiments with a recently-designed sixty-channel P.C.M. equipment were in progress with a view to further assessment of pulse code techniques in practical systems, including scatter link circuits having intrinsically low signal/noise ratios. It was hoped that confirmatory results would be obtained to strengthen what appeared to be a very good case for the use of P.C.M. in satellite communications systems.

In conclusion, the paper discussed reliability and the effects of the space environment. The two great hazards to space operation were radiation and the hard vacuum. Equipment damage resulting from radiation was proportional to the energy, penetrating power and total radiation flux, all of which were a function of height. Prolonged exposure in the lower Van Allen belt of "hard" radiation, the centre of which was at an altitude of 1500 miles, could cause serious trouble, whilst the environment of the hard vacuum and "soft" radiation was conducive to surface erosion.

Since such screening as could be provided against high energy radiation would generate secondary radiation of gamma rays whose damage effect would probably be greater than that of the primary incident radiation, a shield attempting to screen against "hard" radiation did not justify its large part of the payload. Protection from low-level ("soft") radiation might be secured by enclosing all components in a metal can. Components, other than those incorporating moving parts, could be protected against the hard vacuum by encapsulation or potting. Components containing moving parts could only be protected against evaporation by enclosing in sealed boxes. The equipment must withstand an acceleration of 15 *g* over a frequency range of 2000 c/s.

The most rewarding approach was to employ the least sophisticated components and circuits which would fulfil the operational requirement. Such components and circuits must be subjected to, and satisfactorily pass, tests in an environmental chamber arranged to simulate as nearly as possible the space conditions to be encountered. It might be that the required reliability would only be secured at the price of increased size, weight, and power demands, resulting from environment proofing and duplication or triplication of equipment.

Elliptic Orbit System

Particulars of satellite planning and equipment were given in a paper by P. Buss and J. R. Millburn, of Hawker Siddeley Aviation, Ltd., entitled "A Proposal for an Active Communication Satellite System Based on Inclined Elliptic Orbits." Studies of common viewing times from London and New York had shown that a single satellite in a six-hour period elliptic orbit at 63 deg. to the equator, with an apogee height of 12,600 miles, and a perigee of 300 miles, could provide a service between these points for about nine hours a day. Four satellites suitably phased could give almost continuous coverage to all places above 40 deg. North, and a usable, though intermittent, service to places as far South as Australasia. Provided that altitude stabilisation and station keeping could be achieved, the use of three or four satellites in inclined elliptic orbits instead of the circular stationary orbit enabled a good service to be given to the northern hemisphere, with the advantages of reduced range, increased payload, and use of existing launching sites.

The design of satellite described was based on a weight limitation of 550 lb. A single wideband repeater might appear the most flexible system for allowing the satellite to work with more than one pair of ground stations, but various complications arose, and to meet reliability requirements it would be necessary at least to duplicate most of the equipment. The paper therefore proposed a radio installation divided into a number of quite separate non-demodulating repeaters with i.f. amplification. Each unit would consist of transistorised i.f. stages operating at 70 Mc/s, probably with a klystron local oscillator, a triode shift oscillator, and a travelling wave tube output amplifier, the signal being received at 6 kMc/s and retransmitted at 2 kMc/s. Twelve of these unit repeaters, each of 1W output, were proposed. The only method of power supply considered feasible at present was the conversion of solar radiation into electrical energy by silicon voltaic cells. It was shown that a satellite design based on a semi-sun-seeking concept, in which rotation about the earth/satellite axis was used to maximise the output from the solar cell array, could have a radiated power of 12W and a capacity of up to 1000 two-way telephone channels at 40 dB signal/noise ratio.

Power Supplies

Various sources of power for satellites were described in a paper by K. E. V. Willis, of the National Research Development Corporation. Semiconductors seemed well-suited to thermo-electric generation, and voltages of the order of 200μV per deg. Cent. were readily achieved in practice. The performance in this respect of known semiconductors fall off rapidly with temperature, and above about 1000 deg. Cent. they became almost useless. Thus a new class of materials was required for operation at higher temperatures. In the region of 2000 deg. Cent. the so-called "transition" metals (lying near the centre of the periodic table) were suitable.

Another source was the thermionic converter. This was a diode having a high work function cathode and a low work-function anode. The cathode was heated by the heat source to the temperature at which electrons were emitted, and these passed to the anode, returning to the cathode via the external circuit, resulting in the generation

of electrical power in the load. Output voltages between 0·5V and 3V were obtained. The General Dynamics Corporation in the U.S.A. had recently produced a thermionic converter of 90W capability with 10 per cent conversion efficiency at 2000 deg. Cent. The tube contained caesium to neutralise the space charge produced by the electrons in transit between cathode and anode. A device of this nature using argon, or an argon-mercury mixture instead of caesium, which was a very corrosive material, had been developed by Professor D. Gabor at Imperial College under the sponsorship of the N.R.D.C. It had the advantage of being able to generate alternating current. Predicted efficiency figures were 30 per cent for d.c. and 20 per cent for a.c. generation.

Fuel cells presented various problems, and in an effort to increase operating life considerable scientific effort was being directed in the U.S.A. towards development of a regenerative cell in which fuel was generated by making use of thermal (e.g. solar), photochemical, or radio-chemical energy forms.

After reviewing solar and nuclear sources, the paper concluded with a brief account of magneto-hydrodynamic generation (m.h.d.). Space applications of such generators must await further progress in solving the basic materials problems and general engineering development. Although complex, the m.h.d. system was attractive since it offered high conversion efficiency (e.g. 60 per cent) compared with certain other generators.

Navigation Satellites

An account of the collaboration of the Royal Aircraft Establishment with the U.S. "Transit" Doppler navigation project was given by W. A. Johnson, R.A.E. Since 1959 the Establishment had been taking measurements of Doppler curves on transmissions from test satellites. With only four satellites in orbit at any one time it appeared possible to guarantee navigational fixes on nearly any part of the globe at least once every hour and a half. In the "Transit" operational system the satellites would orbit at altitudes optimum for accurate tracking, and the tracking station would receive the Doppler shift signals from each satellite passing within range and transmit these data to the computing centre.

The computing centre would calculate orbital parameters of the satellite for a minimum of one day ahead, and these data would be injected into the satellite for retransmission by it once a minute. The navigational equipment would receive and record the Doppler shift of the satellite transmissions and the orbital data transmitted from the satellite, which would also transmit accurate time signals. From these data the navigator's latitude and longitude might be computed. The Royal Aircraft Establishment Doppler receiving station was situated alongside the interferometer at Lasham, which gave opportunity of comparing the two methods directly, and as in the interferometer case, observations could be made on various frequencies.

Any radio method was dependent on transmission through the atmosphere and ionosphere. The radio waves were refracted, and this would cause both Doppler and interferometer readings to be in error. The refraction error decreased with frequency, and by choice of a sufficiently high frequency the error could be minimised. Further, by observing two frequencies simultaneously, an error correction factor could be found which was sufficiently good for any likely navigational purposes.

Galvanised Strip for Automobiles*

By K. P. SCOTT† and M. H. DAVIES‡

Severe conditions on North American roads due to the use of salt in winter, coupled with the recent change to unitised body construction, forced U.S. motorcar manufacturers to seek more reliable materials to resist corrosion, particularly in critical areas of the main body and underbody assemblies. Of all the materials and coatings tested only zinc coated steel fulfilled the necessary requirements. It seems most likely that the American lead will be followed by British car manufacturers, and in view of the importance of this development to both the zinc and steel industries, two representatives of the former visited the United States at the end of last year in order to obtain the most up-to-date information on materials and techniques.

ZINC-COATED steel has been used in motor cars for many years. Fuel tanks, silencers and exhaust pipes, the ventilation system, window winding mechanisms, head and tail lamp assemblies are typical examples of the many applications, which have in the past been restricted to fittings.

Recently the effect of corrosion on the strength as well as on the appearance of motor cars has forced American automobile manufacturers to use more corrosion resistant materials in critical areas of the main body and underbody assemblies. Changes in methods of construction, i.e. where unitised bodies, constructed out of relatively light gauge sheet, have replaced the conventional chassis and body type of assembly, are mainly responsible, but the increasing use of salt on the roads, for de-icing purposes, is also a major factor.

Of all the commercially feasible protective finishes evaluated by the industry, only zinc coatings have so far provided the required combination of properties with respect to forming, spot welding, and finishing.

The marked growth in demand for zinc coated sheet by the U.S. automobile industry during recent years is shown in the table below. In addition to hot galvanised and electrocoated sheet it is estimated that approximately 9000 tons of zinc dust (for paints) were used by the automobile industry in 1960.

Year	Hot galvanised strip (short tons)	Electrocoated sheet (short tons)
1955	49,376	38,032
1956	58,801	32,256
1957	82,910	41,286
1958	93,967	39,248
1959	106,625	51,655
1960	172,797	46,163

The growth of continuous galvanising in the U.S.A. has been rapid since its inception in 1936 and the new requirements of the motor car companies have further stimulated production of galvanised strip and also the development of special finishing techniques. At the end of 1960 there were thirty-seven working lines, owned by twelve organisations. A further two lines were under construction and scheduled for production in 1961 and one more is expected to be completed by mid-1962. Of particular interest is the trend towards very wide (up to 80in) strip galvanising lines, partly due to the current and probably future needs of the motor car industry.

Production of Galvanised Strip.—Although the demand from the automobile industry has imposed certain problems, there is little doubt that the development has been welcomed by the steel industry and every effort has been made to meet requirements. Initially, sheet with a differential zinc coating was required in order to minimise spot welding difficulties. Advances in spot welding, however, have resulted in a growing demand for uniformly coated sheet possessing a minimised spangle (smooth finish) and a nominal coating weight of 1¼ oz per square foot. While some differentially coated sheet was still being supplied, it is anticipated that demand for this product will cease in the near future.

One of the main problems imposed upon the galvanisers has been the need to produce smoother finishes by reducing the spangle on the sheet. In most cases, this has been achieved by spraying both sides of the strip with steam shortly after its exit from the zinc bath. The type and size of jet used was important, as also was the degree of saturation of the stream. (Cold dilute copper sulphate solutions were used to spray the surface in one case.)

A further refinement in finish was obtained by giving the product a final skin pass through grit blasted rolls, the sheet undergoing between ¼ to 1 per cent reduction in this operation.

It was universal practice in the U.S. steel industry to supply material to make a specified component and not according to a particular specification for composition or mechanical properties. It has been found, however, that for identical steels, the galvanised product was the more difficult to form and consequently a higher quality base metal was sometimes required as a feed material to the galvanising line.

Normal practice of the steel companies was to supply the sheet or strip with a chromated finish as an anti-wet-storage-stain measure. Because of alleged difficulty in welding through the chromated surface, however, all sheet and strip now supplied to the motor car industry is oiled only. Dry material had on occasion been used but was less satisfactory during drawing operations.

While the standard quality sheet (1¼ oz per square foot nominal coating weight) is the predominant requirement, there is an undoubted trend towards tighter specifications and hence closer control over coating thickness. A minimum coating weight of 0·45 oz per square foot per side as measured by the triple spot test and 0·40 oz per square foot per side by a single spot test (as specified in A.S.T.M.; A93) has, for example, been requested in some cases. The normal maximum variations in coating thickness (±10 per cent variation on any one side and ±20 per cent from front to back) have had no significant effect on the welding or forming operations. Nevertheless, steel companies are actively engaged in the examination and installation of electronic devices to control coating thickness.

Automobile Manufacture.—Considerable tonnages of hot dip galvanised strip and also of zinc rich paints have been used, together with a limited amount of electro-galvanised

* The text, bereft of an appendix, of a report of the Zinc Development Association entitled "Use of Galvanised Strip in Automobile Manufacture in U.S.A."

† Imperial Smelting Corporation.
‡ Zinc Development Association.

(one side coated) strip for the protection of underbody sections and skin panels. At the present time, however, special grades of hot galvanised strip are the materials most commonly used for corrosion prone parts of the underbody assemblies. Where skin panels are coated (e.g. bottom of doors, quarter panels and wings), these are usually coated on one side only by spray painting with zinc rich paints.

The presence of the zinc coating has raised problems mainly in connection with spot welding, but also in presswork and in final painting. While each of these problems has been overcome to the extent that acceptable production line techniques have been developed, there is still room for improvement in the materials and in the methods of assembly and finishing.

The knowledge and experience so far gained by the American industry should, however, prove invaluable to the British motor car and galvanised strip industries.

Materials Used

(*a*) *Hot Dip Galvanised Strip.*—Initially because of difficulties associated with spot welding, (large amount of tip dressing required), differentially coated strip (0·15 oz per square foot on one side and 0·5+ oz per square foot on the other) found favour. The differentially coated material certainly gave better electrode performance but was more costly since it necessitated a premium for wiping and marking.

One side coated materials were also developed, but have found limited use for a brief period.

At present, uniformly coated sheet (1¼ oz per square foot nominal) with a matt or spangled finish is being used successfully, due to the improvement in quality control and also in the spot welding techniques. These materials are used to fabricate sections of the underbody and also the rocker panel (or bottom door sill). So far they have not been used for large skin panels.

(*b*) *Zinc Rich Paints.*—Doubts about the ability to spot weld galvanised sheet under production line conditions, and further doubts about the availability of continuously hot-galvanised strip, initially caused one company to employ zinc rich paints to protect critical areas of the underbody and skin panels. During the last three years, however, hot galvanised strip has progressively replaced zinc rich painting for the underbody sections, although the latter technique has been retained for treating the mating surfaces of large floor panels and also parts of the internal surface of doors and wings.

(*c*) *Electro-galvanised Strip.*—Apart from the traditional uses of electro-galvanised sheet, the only new application of note is for the skin panel covering the rear mounted engine of one vehicle.

(*d*) "*Galvannealed*" *Sheet.*—Although used for silencers &c., this material has not proved successful for normal presswork because of the fragmentation of the coating in the dies.

Practice in Motor Car Production

(*a*) *Choice of Steel.*—It is standard practice to supply steel to make a particular part and not to adhere to rigid specifications for mechanical properties or composition.

In general it has been found that a slightly higher quality steel (as galvanised strip) is required compared with the grades of uncoated sheet used in the industry. This is due to the changes in the properties of the material which occur at galvanising temperatures.

Aluminium killed non-ageing steels are used for parts which involve severe drawing, and typical properties quoted by one steel manufacturer are as follows :

U.T.S.	50,000 lb per square inch
0·2 per cent yield ...	37,000 lb per square inch
Elongation (on 2in) ...	38 per cent
Hardness	−50 Rockwell B
Olsen	380mm

(In other cases the Rockwell B values may rise to 53-56, but elongation and cupping test figures are as above.)

Rimming steels are used for parts not so severely worked, and here the hardness may rise to Rockwell B 55 or more.

Another major supplier to the industry quoted the following as typical properties.

(i) Rimmed steel, not temper rolled, 20 gauge and thicker.

U.T.S.	50,000 lb per square inch
Yield stress	40,000 lb per square inch
Elongation	30 to 35 per cent
Hardness	50 to 55 Rockwell B

(ii) Box annealed, aluminium killed steel, with 0·25 per cent temper rolling.

U.T.S.	45,000 lb per square inch
Yield stress	35,000 lb per square inch
Elongation	35 per cent minimum
Hardness	45 Rockwell B

Scribed panels are increasingly being used to assess the ductility requirements in particular forming operations and thus help to define the choice of steel. In some cases it has meant that the more expensive aluminium killed steels have been replaced by rimming steels.

(*b*) *Coating Weight.*—The broad requirement is for sheet meeting the following coating weight specification.

Minimum coating weight 0·8 oz. per square foot (both sides)—single spot test.
Minimum coating weight 0·9 oz. per square foot (both sides)—triple spot test.
Maximum coating weight 1·65 oz. per square foot (both sides).

(*c*) *Finish.*—The standard 1¼ oz per square foot (nominal) coated sheet with a spangled surface is being used by one manufacturer for the underbody sections.

Another major manufacturer demands a matt surface with no visible spangle.

The matt finish is produced by steam cooling and the strip may be given a subsequent pass through grit blasted rolls in order to produce a " minimised spangle—satin finish " grade for some sections.

(A reduction of up to 1 per cent (usually ¼ to ½ per cent) in the temper rolls results in a decrease in the elongation values of the sheet.)

Sheet is supplied oiled only and not chromated.

(*d*) *Forming.*—Apart from a tendency to give slightly more generous radii, no extra allowance is made for galvanised sheet compared with uncoated sheet of the same thickness. The sheet and/or dies must be well lubricated, and no zinc pick-up on the dies is then experienced. In practice die life is found to be increased.

Lancing techniques, where applicable, are used to assist metal feed in the dies.

(*e*) *Spot Welding.*—While satisfactory techniques for spot welding galvanised sheet are well established, the rapidity with which welds are made in motor car production has created special problems mainly due to :

(*i*) Zinc pick-up on the electrodes which leads ultimately to increased tip area, and therefore decreased current densities and poor welds.

(*ii*) The need for more frequent electrode tip dressing, arising from (*i*), which interferes with production and increases the cost.

There are a large number of factors which influence electrode tip performance and weld properties. They include : welding conditions (time, current and load), electrode material and electrode shape, cooling efficiency.

For successful welding, proper selection and control of the welding conditions is more critical with galvanised than with uncoated sheet. Ideally, feed back control from the weld is desirable but machines which incorporate a control mechanism of this type are, at the present time, too expensive. " Slope control," i.e. the gradual build-up of current, offers some advantages but is not widely practised. In the majority of cases simple adjustments have been made to the welding conditions and satisfactory results have been obtained.

General practice is to increase the current and pressure by about 50 per cent and to increase weld time by about 20 per cent compared with normal practice on uncoated steels. (These represent increases of about 10 per cent on current and pressure compared with S.A.E. recommended practice for uncoated sheet.)

Tip Shape.—In spite of the increased difficulty of alignment, tapered tips appear to offer marked advantages with respect to zinc pick-up. There is consequently a pronounced trend towards truncated cone tips although radiused tips and parallel flats are also used.

Tip Material.—Although advantages are claimed for the copper-zirconium alloy tips, the copper chromium alloys (e.g. Mallory No. 2) are more commonly used. Tests now in progress will, it is hoped, establish the superiority of one or other type of alloy.

Tip Cooling.—In spite of experimental evidence to the contrary most welding engineers stress that efficient cooling is a critical factor in obtaining improved tip lives. For truncated cone tips waterhole/flat face distances of ⅜in are used but a reduction to ¼in is thought to be desirable.

It is clear that the frequency of welding will largely determine the rise in tip temperature, and hence the extent of zinc build up on the tip.

Tip Dressing.—The frequency of tip dressing depends on the particular spot welding operation. Thus hand guns, operated at high speeds and making hundreds or even thousands of welds an hour, will require much more frequent dressing than the electrodes on multi-point automatic welding machines for sub-assemblies.

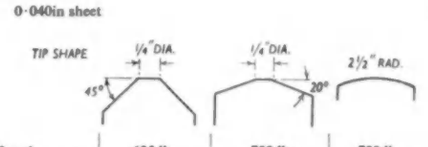
The electrode tips on hand welding guns may either be dressed *in situ* or rapidly replaced for dressing to be carried out elsewhere. In the former case special pneumatic tools have been developed by one company which will dress the conical surfaces (to remove zinc build up) of truncated cone tips but leave the " conditioned " flat face untouched.

For the multi-point automatic welders, where frequent tip dressing would be unacceptable, the conditions are such that average tip lives of 2500 spots are being achieved. This permits dressing at least at half shift intervals but under favourable conditions 3500 spots can be achieved, permitting full shift operation without the need for tip dressing.

Variations in coating thickness within the specified limits do not appear to have an appreciable effect either on tip performance or the properties of the weld.

Typical Conditions.—Examples of the welding conditions used at the present time are as follows :

0·040in sheet



Load	625 lb	700 lb	700 lb
Current (60 cycle a.c.)	12–14,000A	12–14,000A	12–14,000A
Weld time ...	13 cycles	13 cycles	13 cycles

For 0·078in material the diameter of the truncated cone tips is increased to $\frac{5}{16}$in ; weld current is increased to 20—22,000A ; weld time is increased to 21 cycles ; and the load is increased to 1400 lb (for the 45 deg. tip) and to 1680 lb in the other two cases.

Weld Checking.—A simple chisel test is used almost universally to check for satisfactory welding on the production line. " Peel " tests which reveal the size of the weld nugget are, however, becoming more common.

Paint Finishes

The use of hot galvanised strip is largely confined to the underbody where problems of obtaining a high quality paint finish do not arise.

However, some strip is being used for visible parts, such as the rocker panel (bottom door sill), and there is also a trend towards the use of coated sheet for skin panels. In these cases it is desirable to obtain, with the same paints, a finish that will compare with the finish obtained on uncoated steel sheet. In the past it was the practice of one company to scuff the exposed galvanised surface using also a Parker 34 phosphating solution. This would be followed by normal phosphating of the whole assembly. At the present time, however, this practice is being replaced by a single phosphating step (using Parker solution No. 37) which allows a good finish to be obtained on the special grade of hot dip galvanised sheet (minimised spangle satin finish) which is preferred for exterior panels. It has been claimed in one case that a finish equivalent to that on uncoated sheet can be produced. The new phosphating treatment is also claimed to give better chip resistance on coated and uncoated steels. (Spangled surfaces cannot be used since after weathering the spangle shows through the paint.) The hot sprayed phosphating process (Parker No. 37) also eliminates local growth of phosphates (pimpling) which sometimes occurs with the 34 solution.

Zinc Rich Paints.—One major manufacturer has in the past made considerable use of zinc rich paints for protecting the interior surfaces of underbody members and also of skin panels. Although hot dip galvanised strip is progessively replacing zinc rich paints, there will still be some demand for these latter materials. In addition to the spray application of zinc rich paints to the whole or part of the surface of fabricated sections, there is also interest in the one side coating of strip, by roller techniques. In the latter case a great deal of development work has been carried out, but so far no paint has been developed which will permit forming and also be satisfactory for welding. Deformability is essential since it is the internal surfaces of closed-up box sections, &c., which require the added protection of zinc. (Solvent washing of normal paints to leave exposed steel on internal surfaces is one of the main objections to conventional protective systems.)

For spray application, the zinc rich paints should be applicable to oily surfaces, should be weldable and also must have satisfactory corrosion resistance. Very many paints were examined and at the present time " Ironclad " and " Zincolate " are probably the most important proprietary paints, although several other manufacturers have produced zinc rich paints which meet the requirements of the motor-car companies. None of these paints, however, is suitable as a primer for external surfaces, since high paint absorption makes them unsatisfactory for over-painting to produce the necessary high gloss finish. In all cases, therefore, where panels are sprayed on one side, great care is taken to remove any of the over-spray from the external surfaces. At the present time about 10,000 tons of zinc dust is used for paint manufacture in the U.S.A., and of this approximately 9000 tons was required by the motor car industry in 1960. A long oil alkyd is the main vehicle of the paint for car finishes and fine grades of zinc dust with all particles below 20 microns are preferred.

Other Finishes.—Because of the doubt about the suitability of galvanised surfaces as a base for standard external paint finishes, there is still considerable interest in one side coated material, and this may prove to be the ultimate requirement of the automobile industry. A number of processes for producing this type of product are under investigation. In hot dip galvanising they are based on precoating the steel strip with a compound to prevent it becoming wetted by molten zinc. Sodium silicate and sodium aluminate have been used but have not been entirely satisfactory, since they allow the masked surface to be partially coated. Scratch brushing to remove local zinc is, therefore required and results in undesirable scoring of the steel sheet. One steel company claimed that they had developed a water soluble borate masking compound which eliminated this objection.

Electro-galvanised strip (one side coated) is currently being used and it is possible that greater quantities of this material would be required if coatings of adequate thickness could be provided at a cost comparable with hot dip galvanised sheet. Development work is in progress on fast plating techniques.

Proposals for cladding steel strip with sheet zinc or zinc alloys have also been examined but it is unlikely that such clad material could be produced at a sufficiently low cost.

Conclusions

Zinc coated sheet, principally hot dip galvanised, has been established as the most suitable material for certain parts of automobiles subject to severe corrosion.

The introduction of this improved material has involved some modification of the techniques for fabrication, assembly and finishing, but the changes have been relatively slight.

A gradual conversion to unitised construction for all vehicles, and in addition an extension of use (governed partly by cost) to more components will lead to a marked increase in consumption of galvanised sheet by the automobile industry. In the U.S. alone it is estimated that approximately 800,000 to 1,000,000 tons per annum of hot dip galvanised sheet will be required by 1965.

The results of development work in the automobile industry—particularly with respect to spot welding technique—will be most useful in other fabricating industries.

Acknowledgment

This report is based on information obtained during visits to the companies mentioned below : Armco International Corporation ; Weirton Steel Company ; United States Steel Company ; Wheeling Steel Corporation ; The Budd Company, Ltd.; General Motors Corporation ; The Ford Motor Company ; Parker Rustproofing Company, Ltd.; United Paint and Chemical Company ; American Zinc Institute.

Soviet Exhibition at Earls Court

No. III—(*Continued from page* 51, *July* 14)

We continue our account of the Soviet Exhibition which opened at Earls Court on July 7 and is due to continue until July 29. With displays grouped in twenty-two principal sections, covering all major fields of economic and cultural activity, the Exhibition seeks to convey to visitors an impression of what life is like in the Soviet Union at the present time.

RADIO-ACTIVE isotopes are widely applied in research in the biological sciences, technology and medicine, examples from the latter field being shown in the medical section. In industry, radioactive preparations are used for radiography and for measurements and process control, as, in the gauge shown in Fig. 6 which indicates the amount of waterproofing agent or plastic on textile.

Coal-mining and mining machinery includes the "A-2" longwall equipment and the " PKG-4 " tunneling machine. The latter is an 83kW machine designed to drive arch-section headings of 2·8 square metres with gradients of up to 10 per cent at a rate of up to 28m per hour, or to win coal of up to 100 tons per hour.

Metallurgical production is illustrated by an automatic blast furnace and a large electric arc furnace with 7MW supplied to each electrode. The three electrodes are automatically positioned under the control of a computer.

In the section devoted to chemistry visitors can become acquainted with new Soviet methods of obtaining urea. For the production of aniline a catalitic process has

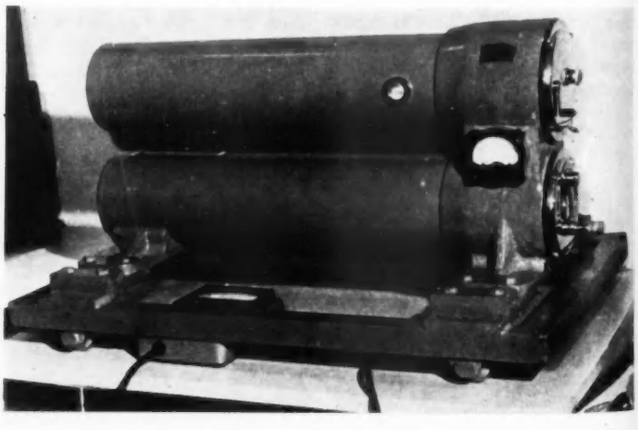


Fig. 6—Beta radiation gauge for the impregnation or coating of fabrics (as in the waterproofing or the manufacture of artificial leather)

been developed which is claimed to be superior to previously known methods. An 8m-long model of the apatite works in the Kola Peninsula conveys some idea of the mining and processing of this important phosphorus-bearing mineral. Also on display is a model of the Rozdolsky sulphur plant, in the Ukraine, showing the dressing mill and the sulphur melting section. Among examples of polymer production are seen articles made of polycarbonate and polyformaldehyde, materials recently discovered by Russian chemists. Synthetic rubber is produced at Sumgait (Azerbaijan) at a plant which is shown as a model. Tyres made of synthetic rubber last, it is claimed, for up to 60,000km as compared with 35,000km to 40,000km for natural rubber.

A large number of machine tools are being demonstrated in use at Earls Court. These include tool room lathes, automatic turret lathes, grinders, welding machines, equipment for ultrasonic machining, and a variety of special purpose machines. Among the machine tools, we mention the model " 584M " semi-automatic gear grinder with programme control, designed for producing helical or straight spur wheels by grinding both flanks of the tooth simultaneously. The model " 1712P " production lathe, a multiple cutter, programme-controlled machine should be mentioned here, also an automatic line for forging and thread-rolling bolts from wire. Adjoining the machine tools may be seen machinery for the textile and boot and shoe industries, and for the printing trade.

Four large halls are occupied by the civil engineering and building sector. On an area totalling 1300 square metres we see several hundred displays, including eighty-four models, some of which are working. In view of the appalling destruction inflicted by the German invasion, house construction and everything that goes with it occupies a major position in Russia. It is one of the aims of the current seven-year plan to solve the housing problem by the building of 15,000,000 flats, as well as 7,000,000 houses in the countryside. In the first two years of the plan (1959 and 1960), 180 million square metres of floor space were completed in the towns. Construction at present, it is stated, runs at 8800 flats per day. In order to achieve this rate of building, much use is being made of prefabrication. At the exhibition this is illustrated by models showing the assembly of flats from concrete panels, or even by using block units each comprising a complete flat which are placed in position by large portal cranes.

The production of concrete panels by " vibro-rolling " is shown by the model of a machine designed by N. J. Kozlov. It consists essentially of a moving belt 3·6m wide and 73·2m long made up of mould elements representing the ribs and panels of the slabs. After pouring and spreading the concrete is compacted by rolling at a pressure of 5 kg per square centimetre (75 lb per square inch) and afterwards steam-cured at 95 to 98 deg. Cent. The belt moves at a speed of 25 to 30 metres per hour.

In the town planning section a glimpse may be obtained of the development of Moscow where on the southern outskirt an entire new district for approximately 1,500,000 people is under construction. The 1959–65 plan for the whole of the capital envisages the building of 25,000,000 square metres of flats, 400 schools (including 119 boarding schools), kindergartens and nurseries for 170,000 children, cinemas with a total of 45,000 seats, hospitals with a total of 21,000 beds, and 1850 shops. An interesting model is the design for a television centre in the form of a 620m high tower.

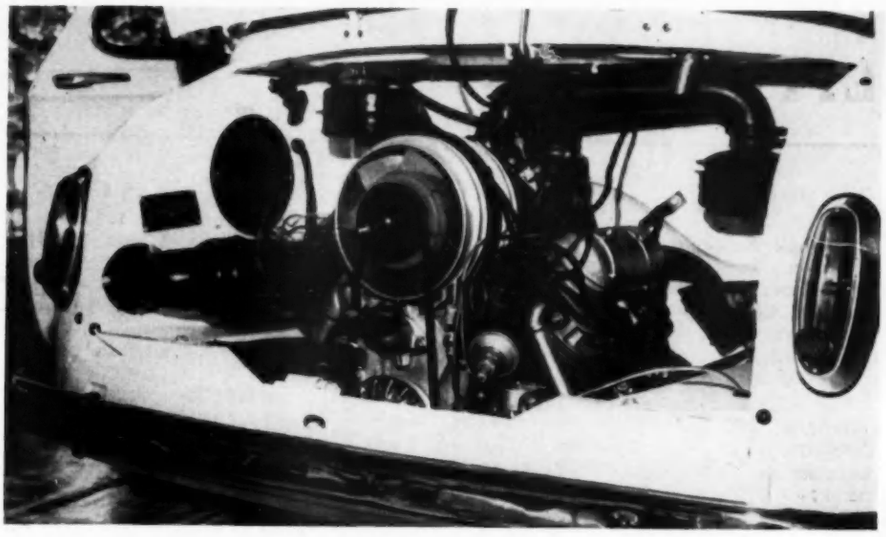


Fig. 7—Four-stroke, 23 h.p., V-4 air-cooled engine of " Zaporozhets " midget car

Present-day trends of interior design and decoration are shown by life-size exhibits of furniture, living rooms and kitchens.

Industrial and public building construction are represented by examples drawn from all over the U.S.S.R. In this section may be seen two models exemplifying the covering of large buildings with wire rope roof trusses. One is a garage of 78m span for the Krasnoyark aluminium-plant, the other is a large theatre.

As regards heavy contractors' plant, there is the 1 : 50 full-scale working model of a 25 cubic metres walking dragline, with a boom 100m long comprising a central tubular strut stayed by three wire ropes. The main motor has a rating of 3200kW. A complete working cycle may be carried out in sixty to ninety seconds. The machine has a stride of 2·3m and exerts a ground pressure through its support pads of 1 kg to 1·5 kg per square centimetre. The model, incidentally, was made by pupils of a Sverdlovsk trade school.

In the transport section are to be seen Soviet motor vehicles, and models of ships and aircraft. Besides vehicles now in series production, such as the passenger cars " Moscovich " and " Volga," there are new models, which are only just going into production, such as the " MAZ-530 " 40-ton dumper, and the " Zaporozhets " baby car, shown in our illustration, Fig. 7.

Models of hydrofoil boats, various designs of cargo and passenger ships, and of the modern airliners Tu-114, Tu-104 and Il-18, and the helicopters Mi-4, Mi-6, and Ka-18 round off the transport display.

A large variety of agricultural and forestry products, amounting to over 1000 different items, are being exhibited in the agricultural section which also presents a range of agricultural machinery, including a self-propelled vertical spindle cotton picker, designed to pick from opened cotton bolls.

Sections on education, consumer goods, health and sports, medicine, books, music, painting and sculpture, and the cinema acquaint the visitor with the development of those aspects of life in Russia.

In connection with the exhibition, a number of lectures are being given by members of the U.S.S.R. Academy of Science. These include talks on space flight, the theory of automation, recent research into the strength of materials, power engineering, crystal chemistry, metal physics, geochemistry, planning and construction of neighbourhood units, coal geology, technical progress in the U.S.S.R., health services and medicine, arrangement of industry in the U.S.S.R., the Soviet cinema to-day and its current problems, trade unions interior layout of houses and communal buildings, Soviet music and art, and several question and answer sessions.

Technical Reports

Cavitation Tests on a Small Centrifugal Pump. (N.E.L. Fluids Report No. 95.) By E. V. Kanellopoulos, Ph.D. National Engineering Laboratory, East Kilbride, Glasgow. No price quoted.—The cessation of cavitation as influenced by the total gas content of water has been studied in a specially designed small centrifugal pump. The impeller and pump casing were made of " Perspex " to allow visual visual observation. Two qualities of water were used ; (*a*) tap water and (*b*) tap water containing a wetting agent. The cessation of cavitation was determined visually by use of stroboscopic light.

Apart from the effects of total gas content and water quality, the influence of rotational speed and of the flow regulating valve opening on cessation pressure were studied. A technique for determining the actual operating conditions at the moment of cessation was developed.

In spite of considerable scatter in the results, a pronounced effect of total gas content on critical cavitation conditions was evident, while a marked hysteresis effect between inception and cessation pressures was noticed for low gas contents. It was concluded that operation of the pump near the best efficiency point provides conditions which minimise cavitation.

Schweizerische Werkzeugmaschinen. By Ch. Rathé. No. 29 of the TR Blue Series. Berne : Verlag Technische Hallwag Rundschau, Berne, Nordring 4. Price S.Fr. 4·80.—This volume of the Blue Series of reprints from " Technische Rundschau " surveys modern trends in the machine tool industry as illustrated by exhibits at last year's Sample Fair at Basle. In particular, the examples show the " operational efficiencies " of machine tools with varying degrees of automation and seek to evaluate the resulting economic advantages in different types of production.

Fortschritte auf dem Gebiete des Giessereiwesens. No. 36 of the TR Blue Series. Berne : Verlag eechnische Rundschau, Hallwag, Berne, Nordring 4. Price S.Fr. 5·80.—The present issue, No. 36 from the TR Blue Series, contains eight papers presented at the twenty-seventh International Foundry Congress, held at Zurich last September. The papers, which have previously appeared in " Technische Rundschau ", deal with high quality cast iron, the metallurgical basis of blast furnaces, molten aluminium, heat treatment of cast iron, the structure of malleable iron, steel castings in Switzerland, cold-setting core binders, and the design of castings.

LITERATURE

Book Reviews

Hydrologic Networks and Methods. Transactions, Inter-regional Seminar, held at Bangkok, Thailand, July 14–27, 1959. Flood Control Series No. 15. United Nations, New York, U.S.A. H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 21s.

THE responsibility for producing and publishing this book lies on the United Nations through its World Meteorological Organisation. The book consists of three parts :

Part I.—Proceedings of the Seminar.

Part II.—Lectures by expert consultants.

Part III.—Papers introduced by participants.

The first remarkable feature to be noticed is the similarity in the meaning of the titles of the three courses of lectures in Part II, namely :

(*a*) Mr. Langbein : " Hydrologic Data Networks and Methods of Extrapolating or Extending Available Hydrologic Data."

(*b*) Mr. Kalinin : " Calculation and Forecasts of Streamflow from Scanty Hydrometric Readings."

(*c*) Mr. Vashnov : " Hydrologic Methods Used When Adequate Hydrometric Readings are not Available."

Engineers must begin to have doubts about what is coming as soon as the word " extrapolation " occurs ; doubts are increased by the phrases " extending available . . data " and " forecasts from scanty . . readings."

Part I recounts the hierarchy of United Nations bodies and its " Conferences," from 1954 to 1959, when this seminar was held. It consists of the United Nations, the World Meteorological Organisation (W.M.O.), the Economic Commission for Asia and the Far East (E.C.A.F.E.) and " Uncle Tom Cobley and all." The irreverent might talk of a mountain in labour, without dwelling on what the mountain brought forth. The rest of Part I is speeches and the necessary acknowledgments. The question, however, arises whether engineers, especially water engineers, should now urge the United Nations to stop putting their prestige behind misleading arguments, and to get the opinion of engineers on engineering. Few engineers were allowed to give their views in the *Transactions*. There are only about twenty engineers and hydrologists among the sixty persons mentioned, of whom only eight or nine are at present employed as irrigation or water engineers.

The law of probability may be of limited and provisional use for calculating mean values, but cannot serve as a basis for design unless regular and frequent observations have been recorded for many years. But the lecturers each declare that they are going to apply probability theory to extrapolated or extended or scanty or inadequate data and thus to deduce figures for flow, &c., in neighbouring catchments and streams where no measurements have been taken at all. Why such lectures on " how to guess " were given under the ægis of the U.N. is difficult to understand for the introduction soundly says " Adequate and long-range hydrologic data are essential in the planning of water resources development schemes."[1] But the lecturers state that the probable error in some calculation is ± 5, ± 20 and even ± 50 per cent, though no definition of " probable error " is given. One authority[2] is quoted as saying that the error in forecasting individual flood peaks may be up to 20 per cent, while in explaining the use of unit hydrographs[3] for forecasting, Mr. Langbein states that errors of up to 50 per cent are not unusual.[4] To state that the probable error in an observation is x per cent does not mean that errors greater than x do not occur ; moreover, probability can say nothing about maxima, while " normal maximum " and " greatest known maximum " are unreliable criteria for flood prevention schemes.

The main problem in working out a scheme is stated to be that of getting the most data possible for a given sum of money. That is putting the cart before the horse, for the rational way is to determine the minimum data required to plan a viable water utilisation scheme and then estimate the cost of collecting these data. It should then be emphasised that extrapolation and other statistical devices give no reliable information and may be very misleading about costs. No experienced water engineer would assume that any given stream would behave just like any similar stream not too far off, as is illustrated below.

First : Glendofin burn, on the south shore of Loch Earn in Perthshire, is a streamlet with the discharge measurable in pails in many summers, like many other streams in the same region. One afternoon in August, 1910, it turned into a torrent, causing a flood and landslide that piled boulders eaves-high round a bungalow on the shores of the Loch. Picture postcards of this effect were on sale for many years.

The second instance comes from tributaries to the upper reach of the Bahr el Gebel (often wrongly called the White Nile). The Kit River is usually crossed on stepping stones or, in the rainy season, in a chair carried by porters, but has been known to come down in flood overnight, with a discharge of about 150 cubic metres per second, while the other frequent streams for the next 100 miles gave no signs of excessive flow. Similar instances could be supplied from many parts of the world.

The chief reason for distrusting the formulæ and equations produced at this seminar on the basis of no data or inadequate data is that in no case has anyone given the comparison of a forecast made by his method at a known date with an actual subsequent flood.

Part III consists of fifteen " Papers on Hydrologic Networks " by thirteen authors, of whom four are meteorologists, one is a senior irrigation engineer in India and one a senior hydrologic worker in Japan. The other eight are obviously experienced in their professions, which are all concerned with water, falling, flowing, or about to fall.

Mr. Y. Kawabata, of the Japanese Government Service (Paper 9 on Meteorological Services in Japan), says the present frequent floods are not due to reckless deforestation, for, owing to river control by embankments and reservoirs, a given rainfall now causes more severe damage than before. This is an impressive warning in respect of all flood prevention schemes. Difficulties met in trying to use the same reservoir for both flood prevention and water supply, support the opinion now held by many U.S.A. engineers that such a reservoir will be inefficient in both its objectives. A flood in 1948 is called " the greatest of all time " following on rainfall in 1947, considered the largest possible, but though the floods of May, 1955, and July, 1956, are stated to have caused much damage, no figures are given to compare with 1947 figures.

Mr. Takenouchi, of the Japanese Government, deals with flood warnings (called " forecasting ") which involve tedious calculations that will be produced shortly by electronic computers. He gives a table showing values of a constant " f " for five characteristic types of catchment ; but as the possible value of this constant for any one catchment is given as varying from 15 to 50 per cent, the " warnings " must be rather sketchy.

Paper No. 12 by Sibte Nabi Naqvi and W. U. Khan of the Pakistan Government, on forecasting floods in the Indus basin without adequate data, gives a comparison between " forecast " and " actual." The paper goes back to " warnings " regularly given by the Irrigation Department from 1885 to 1950, when they used to depend on the " personal experience of individual recipients." The bad floods of 1950 caused the appointment of a Punjab Flood Commission, which started short-period flood warnings, based on twelve " basic elements." " A Comparison of Flood Forecasts issued during 1956–58 for the Ravi and Chenab with Actuals," with the figures for 1370 forecasts is given in Table 42. The results are summarised in the following footnote, quoted verbatim : Footnote on page 143 of the *Transactions* :

Note :

All correct forecasts = 596 = 43 per cent.

Forecast with an error of $\pm 10{,}000$ cusecs = 1037 = 74 per cent.

There seems to be an arithmetical error here. Also, how many forecasts had an error less than $\pm 10{,}000$ cusecs ? Though these short warnings are inaccurate on the whole, users of the warnings " have spoken highly of their utility."

Finally, in Paper 15 on Flood Warnings in India, Mr. Ahuja gives a down-to-earth view of flood warnings that make prophecies by calculations based on the methods of the seminar, showing that they are not successful in practice even for warnings on floods that have begun, much less for floods to come.

The seminar audience must have been composed mostly of amateurs for it had to be told that discharges (" flows ") are measured in cubic metres per second (m^3/sec), that run-off would be greater from a bare rock surface than from other surfaces ; that catchments vary greatly in all natural features from place to place and from time to time, and so on. The thirteen participants in Part III do not need such warnings, but might cavil at a formula (page 28) which contains three undefined constants, or a diagram with six smooth curves and many observations marked by spots, which do not show to which of the curves the spots relate (diagram No. 47, page 88) or a diagram (No. 49, page 89) of five smooth curves and a scatter of spots, through which equally smooth curves

could be drawn more or less at right angles to those shown.

The title of this publication should surely be "Selected Statistics can Prove Anything"!

REFERENCES

("Page" means page in *Proceedings of the Seminar*.)

[1] See page 3.

[2] Reference given by Mr. Langbein on page 38 to a paper by Kresge and Nordenson on "Flood Frequencies derived from River Forecasting Procedures" in the *Proceedings of the American Society of Civil Engineers*, Vol. 81, Separate 630 (February, 1955). These authorities state that "the error in estimating individual flood peaks may be up to 20 per cent."

[3] See THE ENGINEER for August 22, 1952, article "Unit Hydrographs Described" and the work (page 44) by R. Berkeley Thorn "Design of Land Drainage Works" (1955).

[4] For 50 per cent see Langbein, page 35.

Atomic Energy Waste : Its Nature, Use and Disposal. Edited by E. GLUECKAUF. Butterworth and Co. (Publishers), Ltd., 4 and 5, Bell Yard, London, W.C.2. Price 95s.

UNDER the terms of the Radioactive Substances Act, 1960, users of radioactive material have to be registered. The Act is designed to regulate the keeping and use of such material and to make provision as to the disposal and accumulation of radioactive waste. Premises belonging to U.K.A.E.A. or sites licensed under the Nuclear Installations Act, 1959, will need to agree authorisations for the disposal of radioactive waste with the Ministry of Housing and Local Government, the Ministry of Agriculture and Fisheries or the Secretary of State for Scotland. In the United States and other countries, legislation designed to prevent unlawful disposal of radioactive waste either exists or is being prepared, and the whole subject of atomic energy waste is of great national and international interest. The publication of this book is, therefore, opportune. The sea disposal of radioactive waste has already been the subject of an international conference (Monaco, 1959) and this method of disposal is clearly one where, in the absence of reliable data and agreement between countries, it can be the subject of international dispute.

The editor and many of the contributors are employed by the U.K.A.E.A. and are therefore in a position to give a full account of the magnitude of the waste disposal problem and the various methods of dealing with it. Although radioactive waste arises from many sources, such as hospitals, research establishments and industry generally, the overwhelming production is associated with nuclear reactors and the chemical processing of fuel elements. Even at this early stage in the nuclear power age it is estimated that atomic waste in 1961 will be of the order of thousands of millions of curies in the United Kingdom alone.

Part I—"Waste Materials of Atomic Energy" gives a full account of the fission process, fission products and the release of energy and is a very valuable contribution in its own right as well as setting down the fundamentals of the problem.

Part II—"Effects of Radiation on Materials and Living Organisms" gives the necessary data to understand how and at what level of contamination damage can occur to mankind directly or indirectly.

Part IV—"Treatment of Radioactive Waste" sets down the various methods for dealing with low and high active waste. It is in this part of the book that the authors really grapple with the problem of "living" with radioactive waste. The contributors show how knowledge already gained can be skillfully applied to allow the full development of atomic energy without paying either too big a financial price or causing damage to mankind. The editor estimates that out of a total expenditure per year of £100 million there can be satisfactory treatment and storage of waste for a further expenditure of £1,000,000.

Parts V and VI—"Sources of Radiation in Research and Industry" describe the production of large radiation sources and make it clear that fission products made available as part of the atomic energy programme are not necessarily waste : in fact, they may become extremely valuable sources of radiation in food preservation, production of new chemicals or in the modification of the physical properties of a whole range of materials. An interesting example is the sterilisation of medical equipment where heat sterilisation is not possible. There are two clear advantages in making use of the radioactivity of this so-called waste material. Very powerful sources are made available relatively cheaply, e.g., caesium sources for hospital application. The remaining waste has had taken from it elements such as strontium and caesium of relatively long half life, which makes it easier for the remaining material to be disposed of safely.

The editor, Dr. E. Glueckauf, is to be congratulated on his selection of material, and the reader will find that this book gives an up-to-date account of the problem of atomic energy waste.

Electronic Equipment Reliability. By G. W. DUMMER, M.B.E., M.I.E.E., Sen. Mem. I.R.E., and M. GRIFFIN, A.M.Brit.I.R.E. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, London, W.C.2. Price 45s.

RELIABILITY of electronic equipment is a matter of increasing concern to users as the complexity of circuits increases, and conditions of service become more onerous. The authors open by stressing the importance of early failure information from the field, among other sources, being fed back to designers and engineers so that there may be an opportunity of correcting faults before production is completed. Failure rates in electronic equipment are then analysed, and typical faults in valves and other components are described. Subsequent chapters deal with the effects on reliability of environmental conditions and structural design. In the latter connection, current practice in encapsulation, printed circuits and solderless wrapped connections are among the techniques described, illustrated and commented upon.

Proceeding to consider circuit design, the authors explain the contributions to reliability and simple maintenance of preferred circuits, of which numerous examples are shown and the underlying design considerations are explained. A survey of test procedures follows, and the authors then state some of the principles to observe in designing for reliability, with considerable attention to cooling methods. The influence of the human element is studied in a chapter on "Human Engineering," showing methods of eliminating "operator error" by attention to his physical limitations. Methods of reliability prediction and calculation by statistical procedures are explained in a chapter which concludes with a table, based on the authors' own experience, of probable failure rates of common components used under laboratory conditions. The concluding chapter, dealing with reliability in the future, introduces some of the trends associated with micro-miniaturisation, and describes the production of the resistive and capacitive films which may enable conventional tubular components to be superseded. Descriptions of practice in these and many other directions in the course of the eleven chapters make the book of value to the general student of electronic circuits and the components used in them, as well as to the worker directly concerned with reliability. Its value is increased by a bibliography under thirteen headings, and a detailed index.

Possibilités du Décolletage Automatique sur Tours Multibroches. By J. A. GAETAN. Granger, Paris : Editions Eyrolles, 61, Boulevard Saint-Germain, Paris (5e). Price Nf.39.75 (post paid).

As its title "Machining Possibilities on Bar-turning Multispindle Automatics" implies, the present monograph offers an introduction to the finer points as well as to the elementary techniques associated with this class of machine tool. From the vantage point of forty years' industrial experience, the author surveys the situation, and concludes that, generally speaking, these possibilities are seldom exploited in full. "One is led to think that with a few fortunate exceptions . . . tool setters systematically prefer set-ups with the least number of tools to check." This is one of the attitudes the author sets himself to correct, by a careful account of principles and practice, beginning with the installation of a lathe and its trials. Basic operations (defined as those requiring the minimum number of spindle revolutions) with single-point and multi-point cutting are discussed next, followed by chapters on machine time, output rate, multiple tooling, and—perhaps most important of all—two sections, one dealing with the possibilities offered by currently available equipment, the other describing a number of hitherto untried suggestions. With its freely flowing yet precise style, the book reflects the science as well as the dedicated enthusiasm and creative thought which the author has devoted to cultivating his chosen tract of the technological landscape. It will no doubt prove an inspiration to many, including older men, who may like to examine their work from another's viewpoint, and budding production engineers.

Books Received

Électrotechnique Générale. Sixth Edition. By Maurice Denis-Papin. Dunod, 92, Rue Bonaparte, Paris (6e). Price Nf.6.80.

Elementary Machine-Shop Inspection. By R. C. Tatlow. Blackie and Son, Ltd., 16-18, William IV Street, London, W.C.2. Price 9s.

Nuclear Engineering Monographs. Fast Reactors. By R. G. Palmer and A. Platt. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 12s. 6d.

A Short Account of the History of Mathematics. By W. W. Rouse Ball. Dover Publications, Inc., 180, Varick Street, New York 14, N.Y. Price 2.00 dollars.

Boundary Layer and Flow Control. Vol. 1. Edited by G. V. Lachmann. Pergamon Press, Ltd., Headington, Hill Hall, Oxford. Price 210s. per two volumes.

Die Praxis der Induktiven Warmbehandlung. By Kurt Kegel. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, Western Germany. Price DM 31,50.

Prestressed Concrete: Design and Construction. By James R. Libby. The Ronald Press Company, 15, East 26th Street, New York 10, N.Y. Price 12.50 dollars.

Failure and Repair of Concrete Structures. By S. Champion. Contractors Record, Ltd., Lennox House, Norfolk Street, Strand, London, W.C.2. Price 35s.

Prestressed Concrete Cylindrical Tanks. By Leonard R. Creasy. Contractors Record, Ltd., Lennox House, Norfolk Street, Strand, London, W.C.2. Price 35s.

Computer Analyses of Cylindrical Shells. By J. E. Gibson and J. A. L. Matheson. E. and F. N. Spon, Ltd., 22, Henrietta Street, Strand, London, W.C.2. Price 84s.

Space and Condenser, Molecular Theory. By Martin Rollman. Buchruckerei und Verlag Leemann A.G., Arbenzstrasse 20, Zurich 34, Switzerland. Price S.Fr. 12.

Spectral-Isotopic Method for the Determination of Hydrogen in Metals. By A. N. Zaidel, A. N. Petrov and G. V. Veinberg. Butterworths, 4 and 5, Bell Yard, London, W.C.2. Price 30s.

Runcorn–Widnes Bridge

Here we illustrate the steel arch bridge which crosses the River Mersey and the Manchester Ship Canal between Runcorn and Widnes. The bridge is due to be opened to-day by H.R.H. Princess Alexandra. The illustration shows the bridge nearly completed, with the Ship Canal and the Runcorn shore in the foreground. The approach spans on the Widnes side are well shown, but on the Runcorn side there is a much longer approach, comprising thirteen spans of reinforced concrete viaduct, and two steel plate girder spans over the Bridgewater Canal and Runcorn High Street respectively, and also an approach road with a terminal roundabout. The bridge replaces the transporter bridge shown in the background, which will soon be demolished, after about half a century of useful life. The railway bridge in the foreground is around 100 years old ; it has been well maintained, and recently modified for use by electrified services. An instructive contrast in the styles of three periods of bridge building is thus shown.

The new bridge has a main span of 1082ft. Bridge building on this scale has, until recently, been virtually absent from this country since the war, though of course British engineers have been active in this field overseas, and it is therefore particularly pleasing to record the completion of this graceful arch, the more so since it is the precursor of other British bridges of equal or greater magnitude now under construction. Over the next few years at least, a continuous programme of major bridge construction in this country seems assured.

The main structure of the arch is of high-tensile and mild steel, and nearly all the site joints are riveted. Closure of the arch was achieved very satisfactorily, and construction generally went smoothly. A description of the bridge was published in THE ENGINEER of July 22, 1960. The consulting engineers for the bridge are Messrs. Mott, Hay and Anderson, and the main contractors for superstructure and substructure respectively are Dorman Long (Bridge and Engineering), Ltd., and Leonard Fairclough, Ltd. The Princess is also going to open another civil engineering scheme in the area to-day, the River Crossens Drainage Scheme, a note on which will be published in our next issue.

Isle of Wight Car Ferries

By G. W. TRIPP, O.B.E., F.C.G.I., M.I.C.E.

THE existing car ferries plying between Portsmouth and Fishbourne, Isle of Wight, being thirty years old and proving inadequate to the increasing load imposed on them, it was decided to build larger and faster vessels for the service. An order was accordingly placed with Philip and Son, Ltd., Dartmouth, for two vessels to be named "Fishbourne" and "Camber Queen," the time taken for the crossing to be reduced from an hour to thirty-five minutes.

Fig. 1—M.V. "Fishbourne"—Portsmouth/Fishguard, I.O.W. car ferry

The principal dimensions of the new vessels are: length, overall with prows stowed, 166ft 3in; length at waterline, 145ft; breadth, moulded, 30ft, over sponsons, 43ft; depth, moulded amidships, 11ft; draught, loaded, 6ft, tonnage, 292·86 tons gross. Thirty-four average sized cars can be taken and 165 passengers.

The vessels are double ended with hinged loading ramps at each end suitable for working at a slipway. These ramps are hydraulically operated, and are in two sections, and when in stowed position the inboard sections hinge up and make a watertight joint with the bulwarks. The operating gear for the ramps was supplied by MacGregor and Co. (Naval Architects), Ltd., in conjunction with the Lockheed Hydraulic Brake Company.

Propulsion is by means of two Voith Schneider, size 14E/90 cycloidal propellers, one at each end of the vessel, the forward propeller being fitted on the port side, and the aft one on the starboard. With bridge control rapid and good manoeuvring is obtained. Rudders are unnecessary. The main machinery comprises two Crossley type E.G.N. 8/65 unidirectional diesel engines, each driving its associated propeller shafting through a size 41 Fluidrive traction type coupling. Universal joints and cardan shafts supplied by A. Robinson and Co., Ltd., are fitted in the shafting which runs in Cooper split roller bearings, the final drive to the propeller pinion shaft being by means of a Crofts all steel internal gear type N.B. No. 4 flexible coupling. The main engines, which each develop 375 b.h.p. at 650 r.p.m., are fresh-water cooled, the salt water supply to the heat exchangers and the fresh-water circulating being normally performed by engine-driven pumps. A Hamworthy standby fresh-water circulating motor-driven pump is provided.

Lubrication of the main engines is carried out by engine-driven pumps, with one Hamworthy motor-driven pump provided for emergency duties. The three starting air receivers are of Crossley supply. Two Hamworthy "Distar" type air compressors are provided, one motor driven of 8 cubic feet per minute capacity at 350 lb per square inch and one of 6 cubic feet per minute capacity driven by a 3½ h.p. Lister diesel engine. Separate lines from the receivers supply air to the generators, whistle, and sea inlet weed clearing system. A De Laval type 3014X fuel oil purifier is provided, and is fitted with twin pumps, and an Alfa Laval thermostatically controlled electric heater is fitted on the suction side.

Electric current at 225V d.c. for lighting, power, and electric driven auxiliaries is provided by two 60kW Mawdsley generators, driven by Ruston and Hornsby type 6 YEZ diesel engines, running at 1200 r.p.m.

The two general service pumps, supplied by Hamworthy, are of vertical centrifugal type, motor driven. In addition to standby salt water circulating duties for main and generator engines they carry out bilge, wash deck and fire duties. An emergency connection to the sanitary water supply line is also arranged. Sanitary water supply is normally maintained by a "Mono" M.60 type motor-driven pump, a similar pump being provided for supply to domestic fresh-water gravity tank on the bridge deck.

Communication between bridge and engine-room is by means of a Clifford and Snell push-button type telegraph and a sound powered type telephone supplied by the Telephone Manufacturing Company, Ltd.

Apart from passenger accommodation, including a lounge to seat twenty-eight, officer's cabins, toilets and entrances, the main deck is completely clear to allow the stowage of vehicles in straight lines without need for a turntable. There is a lounge at the aft end seating forty-four and a bar/buffet at the forward end seating forty-nine on the lower deck (Fig. 2). The bar and buffet is equipped with a Carron water boiler, G.E.C. hotplate and electric kettle, Belling table type cooker and a "Whirl-a-Waste" disposal unit supplied by W. and G. Sissons, Ltd. Refrigerating equipment, all supplied by the Lightfoot Company, includes domestic type refrigerator, with ice-cream storage section, cooled shelves and 10 gallon water cooler.

Two "Fibreglass" lifeboats of J. S. White's manufacture are provided, the davits for these being of Welin-Machlachlan supply, buoyant apparatus being provided by Messrs. Linklater.

The navigating bridge is situated amidships and extends the full width of the vessel. The wheelhouse is of aluminium alloy, and contains a central control pedestal for the Voith Schneider propellers. Equipment includes Kelvin and Hughes overhead type compass, Decca radar, and a Pye v.h.f. ship to shore communications set. "Wynstrument" windscreen wipers are fitted to the central wheel house windows. The radar scanner is mounted on a mast on the wheel-house top. Marconi sound reproduction equipment is provided to allow announcements to be broadcast to passengers and crew.

The masts at each end of the vessel for navigational lights add somewhat to the strange appearance of the ship, but she has better lines than her predecessor and has been shown to be superior in every way. "Fishbourne" (Fig. 1) is now in service and it is expected that "Camber Queen" will be ready in August.

Fig. 2—M.V. "Fishbourne" car ferry buffet bar

Steel Works Diversification

THERE have been rolling mills at Bromford Ironworks, West Bromwich, Staffordshire, for more than 150 years. At first the works produced wrought iron, but in due course the manufacture of iron was discontinued, and the owner of the works, the Bromford Iron and Steel Company, Ltd., has specialised for a considerable time in the production of hot and cold rolled steel strip. Recently the Company has modernised its cold rolling facilities and has, at the same time, diversified its activities by installing machinery for making an entirely different product—welded wire mesh for concrete reinforcement.

In the cold rolling department a new 8½in and 20in by 26in four-high non-reversing mill has been installed. This mill, built by W. H. A. Robertson and Co., Ltd., Lynton Works, Bedford, is capable of rolling steel strip from 0·020in to 0·156in thick and from 8in to 20½in wide. The maximum rolling speed is 400ft per minute, and the mill will produce coils in weights up to 5 cwt per inch of strip width and 63in maximum outside coil diameter. Feed to the mill is from a decoil box, which takes the coils ready for rolling, and a feeding machine, which is fitted with a pair of 5in diameter pinch rolls and a 5in diameter bending roll for removing curvature from the strip as it uncoils. To deal with the increased output from the new mill the existing heat treatment plant has been augmented by the installation of four new inert atmosphere bell furnaces.

For the production of welded wire mesh a new shop has been built on open land near the rolling mills. This building houses the whole of the mesh-production equipment, which is thus able to function as a separate unit. The building has two bays ; one 200ft by 50ft contains the main mesh production line, while the other, 100ft by 50ft, is available for material stocking and preparation. Hot rolled steel rods in coil form are the raw material, and the plant produces a complete range of wire mesh to British Standard Specification 1221 Part A.

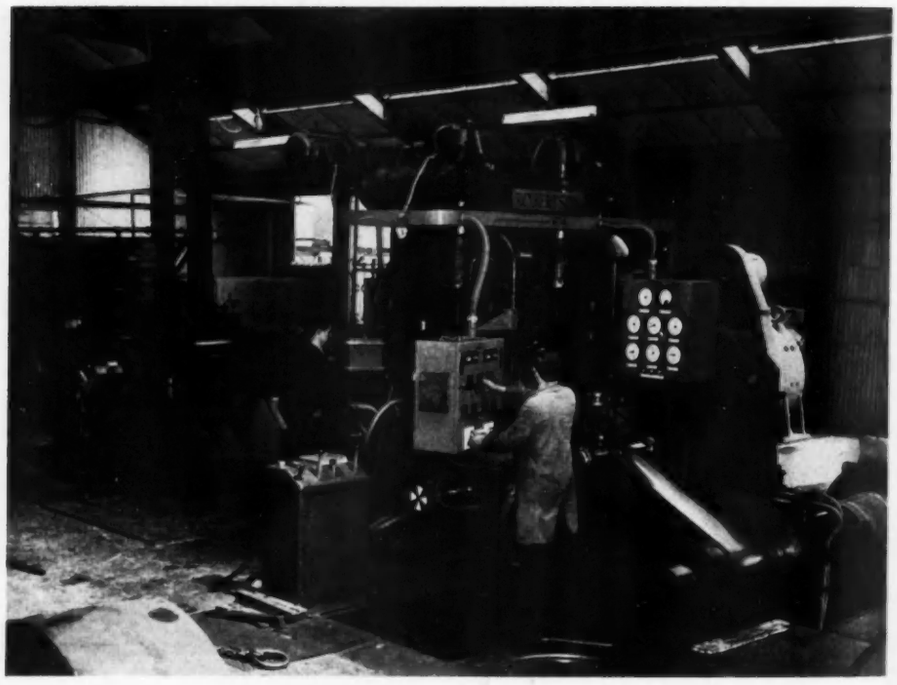
Production starts with the drawing of the hot-rolled rod into wire of a gauge suitable for the mesh. This is done on a " gravity " block made by Sir James Farmer Norton and Co., Ltd., Salford 3, Lancashire. The machine, which has drawing speeds of 400ft, 600ft and 800ft per minute, will handle rod up to a maximum of ½in diameter, and draw it to wire down to a minimum of 14 S.W.G. (0·080in) diameter. Drawing is by the normal method, but the finished wire is discharged below the machine, which is mounted well above floor level. By this construction it is possible to produce much larger coils than usual ; the coils are, in fact, 1 ton in weight. An air ejection mechanism is fitted to assist the operator in removing the coil, and it is possible to complete the removal and continue drawing in about half a minute. Production of 1-ton coils not only means that the wire drawing machine works with the maximum actual production time, but also enables the mesh welding machine to make longer runs.

Coils of wire are transferred to the end of the mesh production line and loaded on to swifts or turntables for feeding into the welding machine. Sufficient of these swifts are provided to enable any required number of main wires to be fed into the machine, according to the size and the type of mesh being made. The mesh machine was supplied by Entwicklung und Verwertung Gesellschaft, Graz, Austria. It consists of seven main elements—a wire straightener, a cross-wire feeding mechanism, multiple electric welding heads, a traction mechanism for drawing the completed mesh through the machine, edge trimmers and slitters, a cross shear for cutting the mesh into sheets, and roll equipment for use when the mesh is required in roll form instead of in cut lengths.

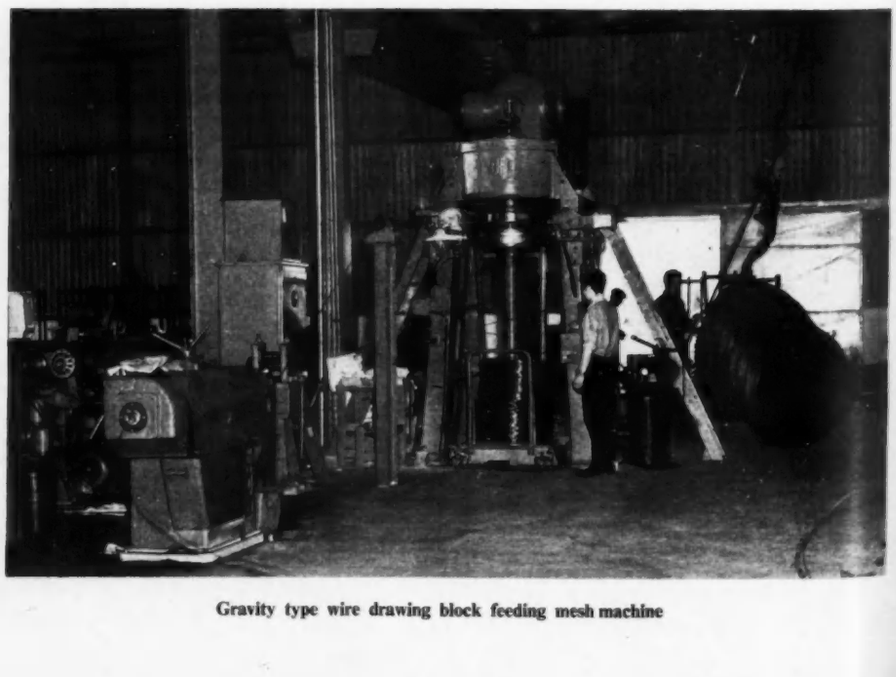
On entering the machine the main wires pass through straightening rolls and then beneath a feed hopper mechanism which places the cross wires in position, one at a time, as the main wires are drawn forward in a series of steps. The cross wires are cut to length and straightened in a separate machine, and loaded into a hopper for feeding. Immediately beyond the cross-wire mechanism are the welding heads, carried on a cross beam, which makes a downwards movement to bring the upper electrodes into contact with the wire cross points, exerts welding pressure and then returns to its upper position. Provision is made in the design of the welding heads for rapid adjustment to suit the whole range of main wire pitches.

Traction through the machine is by means of a hydraulically-driven traction cross-bar, with fingers which engage a cross wire and pull the mesh forward one step at a time. The traction mechanism has stepless stroke adjustment between 1in and 16in ; this covers the B.S.S. range of cross wire spacings. A slitting and trimming mechanism, chain driven from the main machine, is next in line. This can be used to trim the ends of the cross wires and also, as required, to slit the finished mesh, which is made to a maximum width of 8ft, into a number of narrower pieces. The slitting mechanism has six cutting heads, adjustable transversely.

Beyond the trimming and slitting mechanism is a hydraulically-driven cross-cut



Four-high, non-reversing cold mill



Gravity type wire drawing block feeding mesh machine

Cut lengths of wire mesh leaving welding machine

flying shear, which can be used to cut the continuous length of mesh into sheets as required. Alternatively, this shear can be left idle, and the mesh is then rolled on a collapsible mandrel for despatch in rolled form.

Iron Ore Unloader at Cargo Fleet

Iron ore, like other bulk cargoes, must be unloaded quickly. Modern ore carriers are not equipped with handling gear, and the unloading is done by quayside plant. A 15½-ton gross capacity unloader installed recently at Middlesbrough is designed to deal with bulk ore at a rate of up to 400 tons per hour.

BUILT by the Wellman Smith Owen Engineering Corporation, Ltd., Darlaston and London, for the South Durham Steel and Iron Company, Ltd., the unloader is installed at the latter company's Cargo Fleet Ironworks, South Bank, Middlesbrough. It has an outreach sufficient to accommodate 14,000-ton carriers with a beam of 63ft, and the maximum lift of 80ft enables the grab to take ore from the bottom of the carrier hold at all conditions of tide down to low water spring tide. The following are the main dimensions : span, centre to centre of tracks, 46ft 10⅝in ; rail centres (wharfside tracks), 12ft 2¾in ; maximum height of lift, 80ft 0in ; ground rail level to bridge rail level, 67ft 6in ; maximum reach of grab from wharfside, 55ft 0in ; sleeving radius, 14ft 0in.

During normal operation the grab transfers ore from the ship to a large hopper placed on the centre line of the waterside leg structure and immediately over one end of a 3ft 6in wide conveyor belt. The ore passes from the hopper on to a drop-bar grizzly feeder, from which it is transferred to the belt conveyor. This conveyor runs at an angle across the wharf to the landward side of the unloader, of which it is an integral part. At the landward end of the conveyor there are three landing valves, which allow ore to flow either into one of two transfer cars running on tracks at 22ft centres on either side of a storage bunker, or else direct into the bunker itself.

At a low level on the main unloader structure there are two motor-operated spotting hoppers having a traverse covering three lines of railway track. These hoppers allow ore to be deposited direct into railway wagons if required. A further spotting hopper, fixed in this instance, is mounted over the centre line of the outer transfer car track, and the ore grab can also discharge at this point.

The fabricated steel structure of the unloader is carried on twenty-eight wheels, sixteen of them running on the waterside double rail tracks, this arrangement having been adopted in view of a loading restriction of 30 tons to 33 tons per wheel on the wharf. The outer end of the grab trolley boom is hinged to give clearance to ships manoeuvring at the wharf, and when in use its weight is carried by hinged steel ties pivoted at the top of the tower above the main portal part of the structure. Heavy forged steel brackets of special design are provided to ensure alignment of the trolley rail tracks when the boom is in the working position.

The trolley frame and hanger are combined to form one rigid structure, the hanger terminating in a circular steel path to take the slewing guide rollers, which are attached to the central mast. Four double-flanged 2ft 6in diameter wheels carry the trolley, both axles being driven by a 72 h.p. motor through double-reduction spur gearing, giving a trolley traverse speed of 500ft per minute. Both traverse motors are controlled simultaneously from the underslung operator's cabin, the control gear incorporating dynamic braking. A 25 b.h.p. motor drives the slewing gear through worm and spur reduction gear to give a slewing speed of 4ft per minute.

The Priestman grab is of the heavy-duty, four-rope type, with a flush capacity of 115 cubic feet and a heaped capacity of 140 cubic feet. It is carried by a double winch with holding and closing barrels 3ft 6in diameter, each driven by a 100 b.h.p. motor, the speed being 200ft per minute. Series resistance control is provided on the grab hold and close gear in the hoisting position, and dynamic braking and potentiometer control for lowering. In the closing line there is a special jamming relay designed to re-insert resistance into the motor circuit in the event of the grab meeting some object it cannot crush, or if the hold line motor has not accelerated before the grab is clear of the material. Igranic brakes and limit switches are fitted to both these motions. For maintenance purposes a 4-ton hoist block running on a central track is mounted in the machinery house. A separate cabin is mounted below the machinery house for the operator, the grab, hoist, slewing, and traverse motions being controlled from this point ; long traverse and boom hoist are controlled from separate cabins.

A machinery house on the landward side of the apex frame, at main girder top level, contains the boom hoist gear, which is driven by a 25 b.h.p. motor through spur gearing. The boom is latched in the raised position by two massive steel hooks pivoted below the apex structure ; they latch by gravity and are released by thrustors. A control cab at this point houses the controls for boom operation.

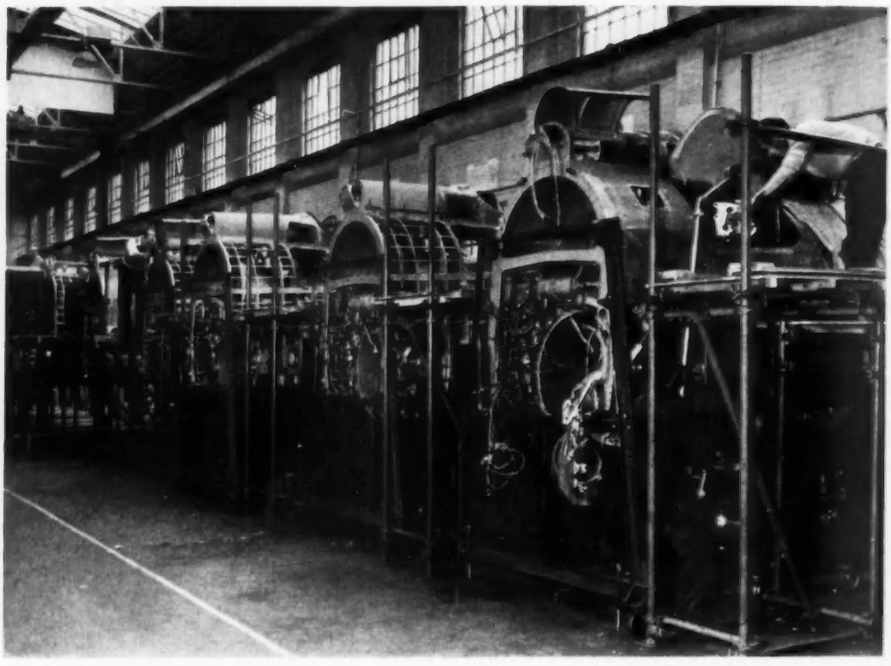
The complete unloader structure is carried on compensated bogies arranged under each corner of the main tower, each bogie having flanged travelling wheels 2ft 6in diameter. There are four 30 b.h.p. long traverse motors, giving a traverse speed of 90ft per minute. The usual wind pressure indicator gear cuts out the travelling circuit and prevents the storm clamps being raised when the wind velocity exceeds a set figure.

Unloader in working position

Fighter Aircraft Production

The production of the airframe of the English Electric " Lightning " all-weather fighter is spread over three factories of the English Electric Company (not of English Electric Aviation, a member of the British Aircraft Corporation) at Preston, where wings and front fuselages are made, Accrington, origin of main fuselage and empennage, and Samlesbury, the assembly plant. Experimental and production test flying is carried out from Warton. Another British Aircraft Corporation member, Bristol Aircraft, Ltd., constructs parts of the airframe.

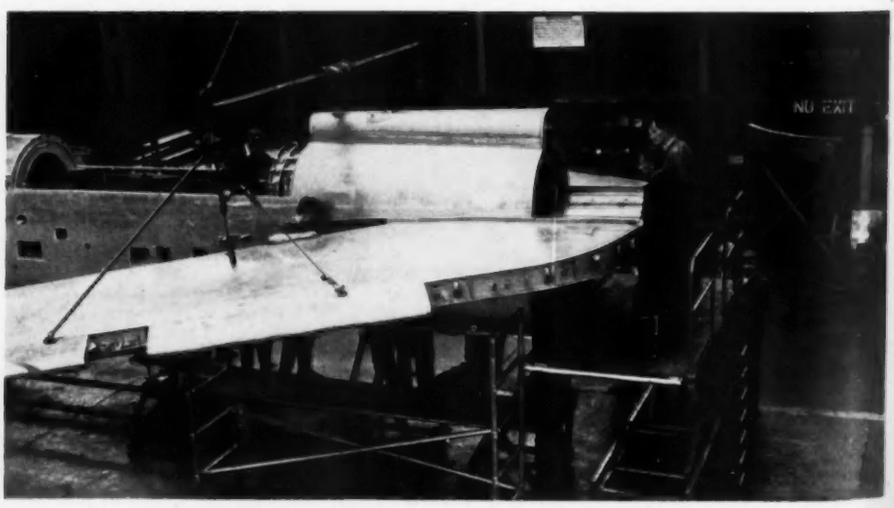
Since the aircraft, as the P.1, was designed for only low supersonic speeds and to have subsonic aerofoils, the shape of the envelope and the manner in which it is supported can be quite conventional. The structure is composed essentially of constant-section sheet assembled to stiffeners with age-hardening rivets, although some of the wing panels are routed to reduced thickness locally and a few parts are chemically milled.



In common with many aircraft designed at the same period for speeds near Mach 1, the " Lightning " consists largely of ducts for the engine working fluid. At the intake end these ducts are part of the airframe, and are the first part of the front fuselage to be built; they are assembled in jigging which envelopes them but is on the structure side of the skin. The ducting is flush-riveted and, in contrast to the exterior, almost devoid of openings. Around the ducting is built a conventional structure, into which is installed a high proportion of the equipment necessary to execute, largely automatically, pursuit interceptions. Because the forward fuselage is occupied by the intake manifold, only one man can work in it at a time, and hence its assembly takes many days and a large number of units are in the works at any time. To avoid rectification work at later stages, rigs are provided on which the functioning of all the installed equipment, such as the pilot's selectors, can be tested while the front fuselage is isolated; another measure of inspection is to rotate the front fuselage about its longitudinal axis and listen for signs of any loose objects. Front fuselages nearing completion are seen ABOVE.

The main fuselage is largely occupied by the engines, the access doors for which occupy large areas at top and bottom; LEFT is a view looking aft from the front engine bay, and showing how the floor of the upper engine bay is strengthened to close the torsion box. In way of the engines titanium is used for much of the interior structure.

The outstanding structural feature of the " Lightning " is that it is a cantilever monoplane; it is this fact that demands a transport joint as well as engine access doors in the fuselage. The wing is built in two halves and joined on the plane of symmetry, being supported outboard during this operation from the main undercarriage pivots. The main torsion box is an integral fuel tank as far out as the undercarriage; the fact that the flaps are oblique to the airstream results in their volume being large and they too are filled with fuel. The leading edge is available for services and a conventional push-rod aileron control circuit runs around it; the brackets for the rod guides can be seen RIGHT. The ailerons are operated by straightforward jacks, the hinge line being moved to the upper surface to afford sufficient leverage within the depth of the tip.



ABOVE is seen the assembly line. On the nearest aircraft there can be discerned the external duct for electric leads in way of the front engine which distinguishes the F.1A and the F.2, which has succeeded it in production, from the F.1 first issued to the Royal Air Force. It may also be possible to distinguish the compressed air system for clearing rain from the windscreen, which consists of an intersecting pair of jets some way in front of the screen (to break up large drops) and a flat jet blowing straight up the screen from the forward edge. On the next aircraft it can be seen how the nose wheel retracts into a pylon in the air intake which is used to support the radar "bullet." At the end of the line the optical weapons sight and the 30mm guns are harmonised ; even over the short distance, *c.* 50ft, used, a marked divergence in the gun boresight lines is visible.

The "Lightning" F.2 is externally indistinguishable from the F.1A. The first of the new mark made its first flight on Tuesday last week ; a Mk.3 version has been spoken of, but in no way described. Some little information has been given about the performance of the aircraft ; with normal flying techniques and heavy use of wheel brakes, it can land on 750 to 800 yards of runway. The handling characteristics at high incidences are those generally associated with aircraft of extreme sweep, even though this machine has a short chord compared to that of a delta, there being no clearly defined stall ; a demonstration of an F.2 (seen BELOW) in flight confirmed this, extreme angles of attack being apparent from the ground. While the machine can be spun from about 135 knots, a complete stall would involve flying below 100 knots.

SHORTER REPORTS

BEAMA Statement on Future Screw Thread Practice

IN 1958 the British Electrical and Allied Manufacturers' Association issued a pamphlet reiterating its policy and expanding its reasons why Whitworth and B.A. threads should continue to be used as the standard production practice of the industry. The International Standards Organisation was unable to obtain agreement on one recommended future world practice, and it will issue two recommendations of equal status, one an Inch System—the Unified Inch Thread, the other a Metric System—the Unified Metric Thread.

A statement which has now been issued by BEAMA says that whilst there is, as yet, no indication that Whitworth and B.A. threads are now less generally acceptable at home or overseas than in the past, if and when the I.S.O. recommendations are adopted then it must be foreseen that Whitworth and B.A. threads will become obsolescent as generally acceptable practice. If then a standard interchangeable production practice is to be maintained within the United Kingdom electrical and allied industries in the future, co-operative consideration of future practice is essential. With this in mind the BEAMA Council, some six months ago, initiated among its member firms an inquiry directed towards long-term consideration of the relevant factors which should influence future policy. These considerations included the importance to the industry and its customers of having a common screw thread policy, the significance of exports to " metric " and to " inch " using countries and likely future influences in those export markets, any existing demand for the unified inch threads, and generally an attempt to foresee the long-term trends.

The results of this inquiry show that a substantial and unmistakable majority opinion is that, when the time comes to make a change, it should be to the I.S.O. metric thread and that it is desirable to maintain a common normal production practice within the electrical and allied industries.

The reasons given by individual members were detailed in relation to their particular products and present and future markets. In particular it emerged that there is a widely held view that, when the time comes to change from Whitworth and B.A. threads, the adoption of another inch thread might well prove to be only an interim measure which would thus involve members—and their customers—in a duplication of the substantial costs and disturbances which any such change must entail. In the light of this consensus of member opinions it is the intention of BEAMA to initiate discussions with the major customer and trade interests with which they are concerned so as to seek to work out an acceptable long-term plan for giving effect to this screw thread policy.

High-Viscosity-Index Motor Oils

A RANGE of five engine oils is now being marketed in Great Britain by Veedol (U.K.), Ltd., formerly Tidewater Oil Company (England), Ltd., of Villiers House, Strand, London, W.C.2. Although Veedol oils are internationally available (in more than eighty countries) those sold in this country are not only blended here but use additives of British manufacture. All the oils are available in vessels holding 45 gallons, 5 gallons, 1 gallon, 1 quart or 1 pint ; the two last sizes are sealed cans from which the oil is released by means of a special hollow opener that seals on to the top of the can to act as a pouring spout.

" 10-30 " motor oil is of " mixed " viscosity, ranging from SAE 10W to 30. It meets the requirements of M.S. Mil-L-2104A Supplement I. The anti-wear additive is zinc di-thiophosphate, and the oil is considered to be adequate to protect engines with push-rod valve gear. The base oil is of low carbon residue and minimal combustion chamber deposits are claimed to be obtained.

" Heavy Duty Plus " 20W-30 motor oil exceeds the requirements of Mil-L-2104A Supplement I, and is claimed to be the only such oil marketed in this country ; it is not, however, regarded as a true multi-grade oil.

" Premium " 20W-30 motor oil is recommended for petrol engines where there is no call, as from hydraulic tappets, for high detergency. It is substantially less expensive then the above-mentioned oils.

" Adelbus " S.I. and " Atline " motor oils are both claimed to be of high viscosity index and are recommended for diesel engines (where fuel sulphur contents are high but not greater than 1 per cent) and for petrol engines respectively.

[Reply Card No. 1106]

Proposed Yorkshire Power Stations: Eggborough and Ferrybridge

THE West Riding County Council has approved the Central Electricity Generating Board's applications for permission to build two large coal fired power stations on the River Aire, one at Eggborough about 4 miles east of Knottingley, and one adjoining the existing station at Ferrybridge. The local authorities concerned, Selby and Osgoldcross at Eggborough and Castleford and Knottingley at Ferrybridge, have also approved the schemes. The Generating Board now awaits the decision of the Minister of Power whose consent must be obtained.

Each of the stations is planned to have a total installed capacity of 2000MW and will burn up to 5,000,000 tons of coal a year. Most, if not all, of this coal would be drawn from the Yorkshire coal field. The stations thus provide a convenient and efficient method of using the quantities of small coals which are unsuitable for the domestic hearth but which are becoming increasingly available in the West Riding. With two chimneys 650ft high and eight cooling towers, each station would be a conspicuous landmark. The Generating Board is conscious of this and has agreed that the layout and architectural treatment, and the landscaping of the sites, should be subject to the County Council's approval. The burning of such large quantities of the high-ash product of the Yorkshire coal field presents a major problem ; when fully operating, each station would produce more than 100 tons of ash an hour. The Generating Board is, therefore, putting plans to the West Riding County Council concerning the disposal of ash.

Lancashire—Yorkshire Motorway

THE Minister of Transport, Mr. Ernest Marples, has authorised the County Councils of Lancashire and the West Riding of Yorkshire as his agent authorities to make a preliminary survey for a line of route within their respective counties for the proposed Lancashire-Yorkshire Motorway.

The 50-mile route to be surveyed will begin at Worsley on the northern outskirts of Manchester, where the first few miles of the road will serve as part of the Manchester outer ring road ; it will end at Ledsham on the A1 about 10 miles west of Selby. The aim is to plan a new fast route across the Pennines to link the industrial areas of Lancashire and Yorkshire and to relieve the existing highway system of its burden of east-west traffic. The new route will also give better access from these areas to the north-south major motorways (M1 and M6) and to the Great North Road. The new route is also intended to connect with an improved highway system between Liverpool and Manchester, and between the Great North Road and Hull. The Ministry points out that preparation of a new large motorway scheme is a lengthy undertaking, and it will inevitably be some years before work can start.

World List of Nuclear Research Institutions

IN order to facilitate the exchange of information between nuclear scientists, engineers, and administrators, the International Atomic Energy Agency, Vienna, is publishing the names and addresses, together with summaries of their activities, of institutions in member countries connected with nuclear technology and research. The list appears in sections at irregular intervals as information is received, and applications for copies should be addressed to the I.A.E.A., Kärntnerring, Vienna I, Austria.

Valves for Hot Water Heating Systems

A NEW range of radiator valves, in sizes from ⅜in to 1in, has been introduced by Hattersley (Ormskirk), Ltd., Ormskirk, Lancs, in straight and angle designs for use on low and medium pressure hot water heating systems of up to 150 lb per square inch and 250 deg. Fah.

The valves, one of which can be seen in the illustration below, have streamlined, compact handwheels and lockshields in ivory coloured thermoplastic material and have P.T.F.E. impregnated asbestos packed glands.

The bodies and tail pipes, made of cast bronze, can be supplied with the natural cast finish or polished or chromium-plated. The angle pattern

Valve for hot water heating systems up to 150 lb per square inch and 250 deg. Fah.

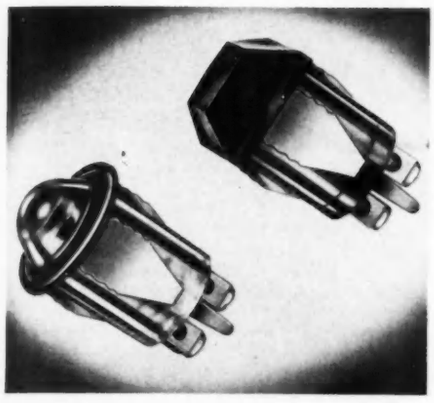
valves have spherically seated disks for proportional flow control, and both angle and straight designs back-seat in the fully open position. Wheel valves can be converted to lockshield valves or vice versa, and the lockshield valves have a concealed indicator under the shield to enable their accurate adjustment either in relation to the fully open position or a known flow/head loss relationship.

[Reply Card No. 1098]

Signal Lamps

Two basic forms of disposable signal lamp unit are being introduced by the Special Products Division of Thorn Electrical Industries, Ltd., Thorn House, Upper St. Martin's Lane, London, W.C.2. They have been designed for simplicity of installation, the complete unit being held in position in a 0·629in diameter hole by steel spring plates, so that no screws or retaining nuts are needed. When effective life is ended, a unit may be discarded and a new one inserted. Connections are made by means of screw terminals.

The illustration shows on the left the form taken by the SGF16 (neon) or SGF20 (neon or incandescent) unit. The SGF16 is for operation up to 70 deg. Cent. and is available for 110V, 220V or 500V. Maximum operating temperature of the SGF20 unit is 125 deg. Cent. The incandescent version of the lamp is available for 4V, 6V, 12V, 24V, 36V or 48V, and the neon version for 110V, 220V or 380V.



Spring-held disposable signal lamp units for incandescent or neon light sources

On the right of the illustration is the SGF1717 unit, designed for extreme temperature conditions. Temperatures as high as 135 deg. Cent. are withstood, making this indicator lamp particularly suitable for electric cookers, frying ovens and heat treatment plant. This unit measures 1·377in long and is available in a variety of lamp colours. The incandescent version is available for 110V, 220V or 380V and has a life expectancy of 5000 hours.

[Reply Card No. 1094]

Descaling Powder

A DESCALING powder, introduced by the Atlas Preservative Company, Ltd., Erith, Kent, for marine applications, is a dry crystalline acid-based material containing corrosion inhibitors and wetting agents. It is stated to be almost totally safe to handle, stow and use on board, and only when mixed with water must the normal precautions be observed for handling acids. The powder is supplied in waterproof polythene-lined disposable metal drums containing a net weight of 50 lbs of powder. Inhibitors incorporated in the powder prevent it attacking the majority of metals, while the wetting agents ensure rapid wetting and solution of scale even where oil contamination of the equipment has occurred. The powder, in either crystalline or solution form, is non-fuming; any vapours formed during scale removal are stated by the makers to be non-toxic, non-irritating and non-hazardous to personnel and non-corrosive to equipment. Either fresh water or sea water can be used to prepare the descaling solution.

Under the cleaning procedure the descaling powder is dissolved in water (either fresh or salt) in the ratio, in the first instance, of 1 lb of powder to 1 gallon of water. With experience this ratio can be either increased or decreased, depending on the amount of scale present. To facilitate the process, an automatic colour indicator is incorporated in the descaling powder. This colour indicator produces a light red solution when the mixture is cold, and turns it deep red on heating. As the scale is dissolved, thus consuming the descaling solution, the colour gradually changes from blood red to orange, indicating 85 per cent of the initial charge of the descaling powder has been used. If scale is still present when the colour has changed to orange, then the attack on the scale will diminish, but the addition of further descaling powder will reactivate the solution and turn the colour back to red. In the case of equipment which is lightly scaled, the scale may be removed without any change in the colour of the descaling solution, the cessation of gas evolution being an indication that the descaling process is complete. Heating and/or circulating the solution speeds up the descaling process, but the temperature should not exceed 170 deg. Fah.

[Reply Card No. 1099]

Photo-Elastic Stress Analysis

WE illustrate a 5½in diameter polariscope for photo-elastic stress analysis which is being introduced by the Sharples Engineering Company (Bamber Bridge), Ltd., Hillcrest Works, Chorley Road, Walton-le-Dale, Preston. This instrument is adaptable by the user as a diffused light or a transmission polariscope. The diffused light method helps visual examination by absence of glare from lenses, is adaptable for quick measurements, and provides high definition of fringe photographs. Advantages of the transmission system are its convenience for group viewing, facility of drawing isoclinine lines, and better alignments of model boundaries in the image.

Light sources for diffused light operation are a 60W sodium lamp for producing monochromatic light, and two 150W tungsten filament lamps. These are contained in a detachable lamp house with diffusing screen, together with a rotatable shield to cut off the light from the sodium lamp when the tungsten lamps are in use, thus avoiding the need for frequent switching of the sodium source. The 5½in diameter Polaroid shoes and quartz-wave plates can be rotated separately through 360 deg. It is possible to correct the effect of the quartz-wave plates by an appropriate setting of each, giving plane polarisation for examination of isoclinics. Resetting of the plates connects the polariscope back into a circularly-polarised instrument for examination of the isochromatics.

Polariscope and loading frame

Loading of models is normally through a lever and dead-weight system; tensile, compressive, flexural and torsional loads can be applied. Provision is made for vertical and transverse movement of the loaded models, and a swivel movement allows adjustment for space effect. The camera stand can be adapted to take any 35mm camera, and larger cameras can be used if desired.

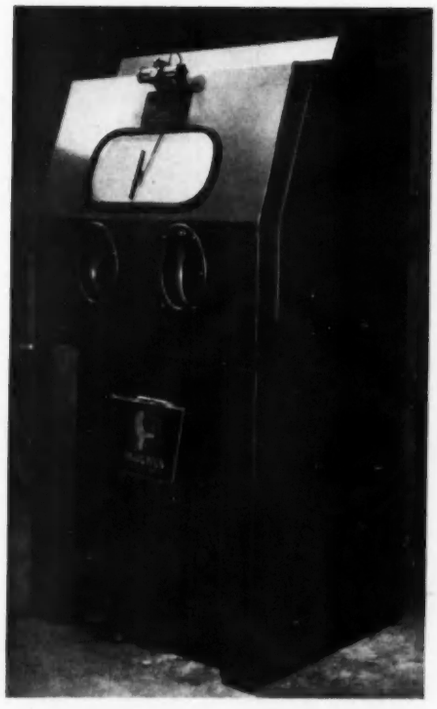
To convert the diffused light polariscope into a transmission instrument, it is only necessary to replace the lamp house with a special platform carrying a 250V compact source mercury vapour lamp, a 150W tungsten filament lamp and a 6in diameter condenser lens of optical quality. The tungsten lamp can be brought into use by switching on and swivelling a mirror into position, which directs the white light through the condenser lens and at the same time screens off light from the mercury vapour lamp. At the other end of the polariscope, a sliding bellows mounting is provided to carry the camera lens, which then serves as a projection lens. A glass screen to accept tracing paper is fitted to receive the projected image.

[Reply Card No. 1095]

Vapour Peening Machine

THE vapour peening machine shown in the accompanying illustration has been developed by the Magnus Chemical Company, Ltd., Industrial Estate, Uxbridge, Middx, for treating and cleaning metal surfaces prior to further processing. It is designed to use fine lead-free glass beads and, although any other water suspendable media can be used, glass bead media have an advantage in that there is no loss of metal surface or dimensional change effected in the cleaning operation.

The machine is of welded sheet steel construction with a 28in square by 35in long booth or working chamber. Its holding tank takes 1 gallon of water with 4 lb of glass beads and incorporates an agitating device to maintain the beads in suspension. The booth, internally lighted by two fluorescent tubes, has a 20in by 9in sight glass fitted with a windscreen wiper, and its atmosphere is kept clear by an extractor fan to enable constant clear visual inspection of the work in progress. Vapour extracted from the booth is returned to the holding tank via a cyclone separator.



Compressed air operated vapour peening machine with a 28in square by 36in long booth

The vapour blast effect is achieved by compressed air, the glass bead slurry being atomised by a venturi in the hand gun. The air supply to the hand gun is pedal controlled so that both of the operator's hands are free to manipulate the gun and workpieces.

[Reply Card No. 1101]

SHORTER REPORTS *(Continued)*

British Welding Research Association

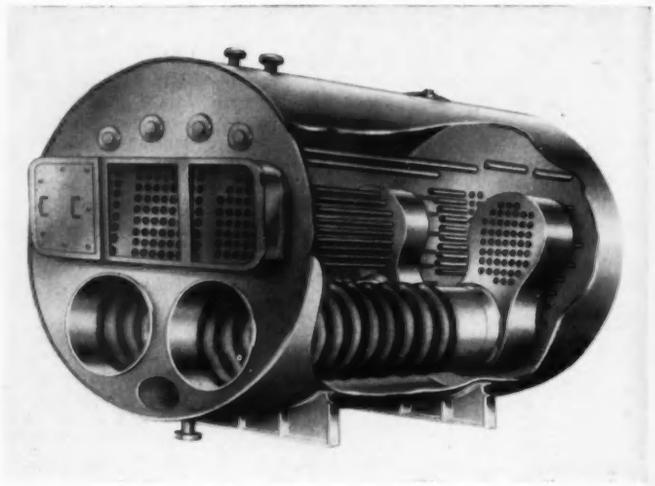
A NEW engineering laboratory at the British Welding Research Association, Abington Hall, Cambridge, was opened recently by the Rt. Hon. Lord Mills, P.C., K.B.E., and on the same day an exhibition of work in progress was staged by the Association. The engineering laboratory, a two-storey building of 21,000 square feet, houses the pressure vessel, brittle fracture, and resistance welding sections, together with an extensive machine shop on the ground floor ; offices and conference rooms occupy the upper floor. Like the other post-war buildings at Abington, the new laboratory is a plastically designed, all-welded steel-frame structure.

Among the work in progress friction welding and tensile testing of welded joints in heavy steel plate are of particular interest, special equipment having been designed and built by the Association to obtain the required data.

Friction welding is in production use in Russia and it is generally believed that the process is of Russian origin. In fact, however, the Russian designs date from 1956, and British patents were taken out in 1941 and 1942. The process is basically simple. If the ends of two bars are held in contact and one of them is rotated, friction at the interface generates sufficient heat for welding to take place when the relative motion is stopped and axial force is applied. The process has some of the advantages of the better known resistance welding techniques, but requires much less power. A machine built by the Association for friction welding experiments is shown in one of our illustrations. It has two co-axially mounted chucks for carrying the pieces to be welded, and one chuck is driven by a standard 10 h.p. motor running at 950 r.p.m., the work speed being 430, 640, 800 or 1200 r.p.m. Axial force is provided by a 12in diameter double-acting air cylinder which, working at 100 lb per square inch, gives upset and friction forces up to 5 tons. To stop the relative motion between the two work-pieces when the required welding heat has been reached, the normally stationary shaft is accelerated up to the speed of the decelerating driven shaft at the appropriate point in the cycle.

For tensile testing of welded joints in heavy steel plate the Association has had in use for some time machines of its own design, of 700 and 2000 tons capacity. A new machine has now been designed and is under construction for applying tensile loads up to 4000 tons. It will be capable of producing fracture in alloy steel plates up to 4in thick and mild steel plates up to 6in thick. As in the existing machines, the loading will be by means of hydraulic capsules, but four large capsules, working at pressures up to 8000 lb per square inch, will be used instead of a larger number of hydraulic units with lower pressure.

The principle of the testing machine can be seen from the second of our illustrations, which shows the 700-ton rig. Two of the hydraulic capsules are visible on the left of the specimen and the one load-bearing end of the rig is prominent on the right, with two push-rods extending from it to the capsules. The specimen under test is welded to the load-bearing ends, and the pieces are machine gas-cut off after testing.



A three-pass wet back "Maxecon" boiler

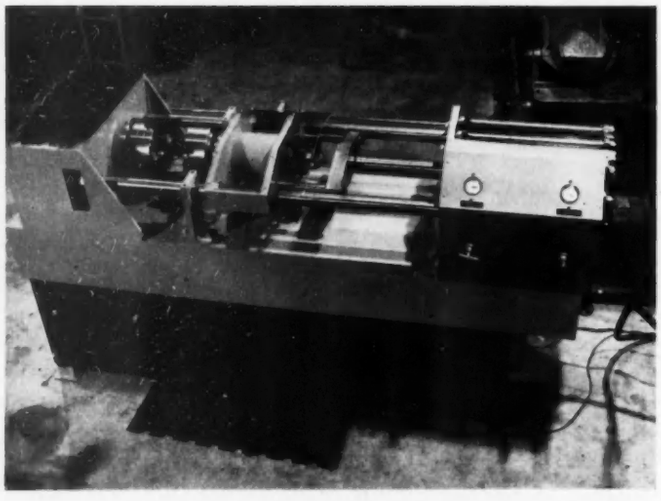
Wet Back Shell Boiler

A RECENT development by Richardsons, Westgarth (Hartlepool), Ltd., is a three-pass wet back boiler known as the "Maxecon" which has superseded the company's older three-pass dry back unit.

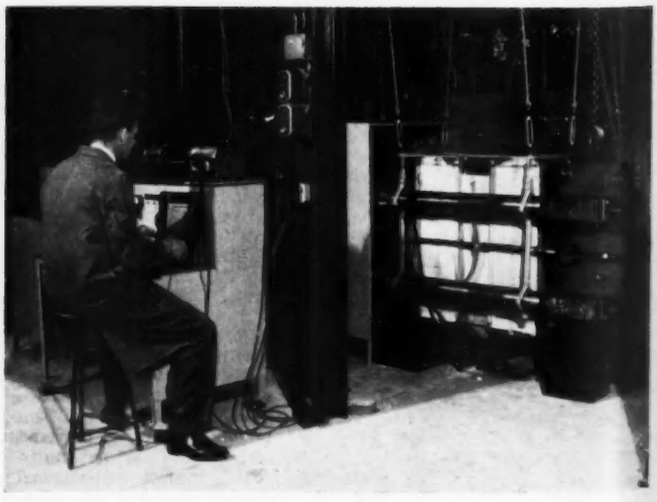
Modern welding techniques have been employed to streamline the design, in which each fully corrugated furnace has a separate combustion chamber, set at an angle and supported on the back end plate by stay bars. The front plate of the combustion chamber forms the second pass tube plate, while the third pass is fitted between the front and back end plates and the tubes run along the centre of the boiler between the combustion chambers. Each of the four tube plates is at an even temperature. Twenty-five per cent of the smoke tubes are stay tubes which evenly support the end plates and thus stay bars are only required in the steam space. The tube spacing leaves adequate space for cleaning and the design provides adequate access for internal inspection and maintenance, while the absence of cross stays allows for inspection between the furnaces. Internal examination of the furnace and combustion chamber is assisted by mounting the Hamworthy oil burning equipment on a hinged plate. Furthermore, the elimination of combustion chamber brickwork effects a maintenance saving and reduces heat loss due to radiation.

The boiler, for which a thermal efficiency of over 80 per cent at all loads is claimed, produces high quality steam and has good flexibility to meet fluctuating loads, due to the large steam space; output can be increased from zero to M.C.R. in two minutes without significant drop in pressure. A steam pressure of up to 250 lb per square inch gauge can be attained and it is stated that no part of the boiler exceeds 70 deg. Fah. above saturation temperature. The boiler is readily convertible to burn oil up to 3500 seconds Redwood No. 1, gas or solid fuel, and is capable of raising steam in fifteen minutes from lighting up. Superheat up to 100 deg. Fah. can be supplied and the boiler provided with fully automatic or semi-automatic controls. The boiler only occupies about 75 per cent of the floor area required for a dry back unit and the double furnace units, one of which we illustrate, have a rating from 11,000 lb to 23,000 lb per hour with special units for ratings above 23,000 lb per hour, while single furnace boilers covering the range 4000 lb to 10,000 lb per hour are under development.

[Reply Card No. 1105]



Prototype friction welding machine

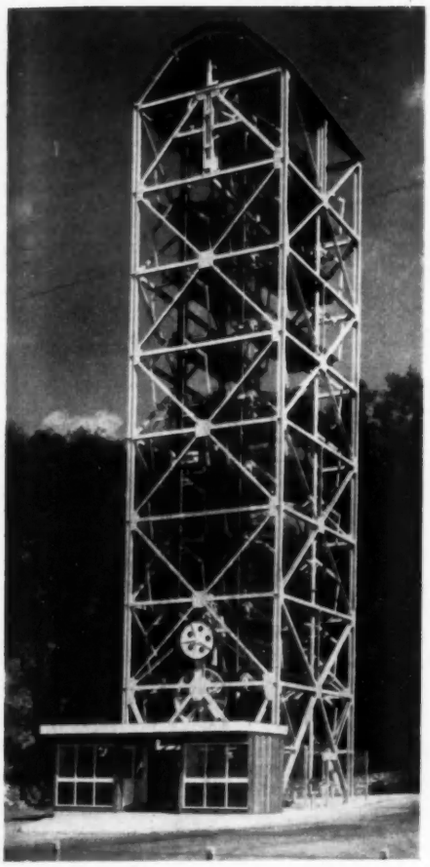


Tensile machine for testing welds in heavy steel plate

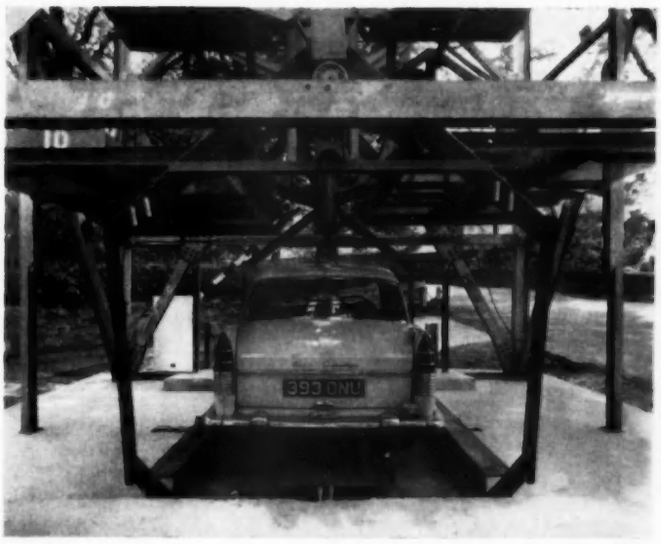
Car Parking Lift

THE accompanying illustrations show a device for parking twenty cars known as the "Wulpa Liftpark," which has been erected by the Butterley Company, Ltd., at its works at Ripley. The company has been responsible for introducing this system of parking into this country ; it is based on the Paternoster lift and on later Swiss patents.

The car to be parked is driven onto a cradle—well shown in the second illustration—which is



"Vertical" car park for twenty cars, comprising cradles suspended from a pair of endless chains



A cradle in the loading position at ground level

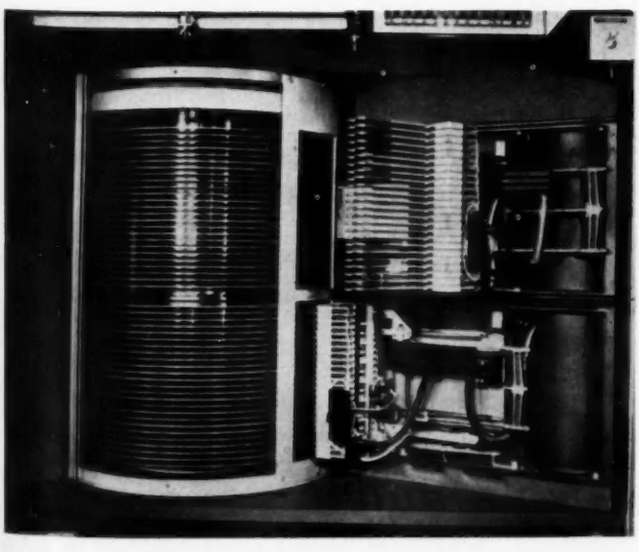
suspended from a pair of continuous chains. The first illustration shows the whole mechanism, with a drive wheel at the bottom and idler wheels at the top of the tower. A "drive chassis.' comprising an electric motor of 45 h.p., reduction gearing and a shaft, all mounted on a frame, was built into the tower as a unit. The final stages of its reduction gearing can be seen in the illustration. At the top of the tower there are straightforward arrangements for adjusting the tension in the chains. The chains run in guides on the tower structure. The pitch of the chains is 16in, their ultimate strength 135 tons, and the total weight of chain in the installation is 5 tons.

The tower is conventionally designed in structural steel ; it is 90ft high. The cradles have chequer-plate floors, with built-in chocks to hold the front wheels of a car. Two nylon wheels are carried just below and beside the floor of each cradle. These wheels run in guides on the tower, and the cradle rests on them (one of them can just be seen in the second illustration) the wheels in their turn resting on an inclined bearing surface, when the cradle is in the loading and unloading position at ground level. A three-armed spider, with nylon wheels at the tip of each arm, rotates with each of the big chain wheels, and as the guide wheels just referred to leave the vertical guides in the tower as the cradle is carried round at the top or the bottom, one of these wheels on the spider arm engages in a recess in the frame of the cradle immediately above its suspension pin, thus preventing the cradle from rocking.

A feature of the system is a complete system of automatic control, incorporating lifting barrier gates and photo-electric cells scanning entry, exit and the cradle on the ground. This control system results in a panel which has a latch key and numbered latch for it corresponding to each cradle. The key can be turned to three positions, "park," "unpark" and "vacant," and can only be removed when turned to "park." The average time to recall a cradle to ground level is thirty seconds, and the longest time two minutes. Alternatively manual control of the installation is equally practicable.

The whole installation follows "fail safe" principles ; a small petrol motor is installed for use, with manual control, should there be a prolonged failure of power. Architectural detailing is flexible, and the lift can be installed in existing buildings in some cases. The twenty cradles will each take a car up to 19ft long and up to 2 tons in weight. The approximate cost of this lift for twenty cars is £15,000 ; it is thought that production and other developments in the design of future lifts will result in a lower cost ultimately.

[Reply Card No. 1091]



Disc stores, left, and access arms of computer data storage system

Disc Storage Unit for Computers

STORAGE of up to fifty-six million characters is provided in a random access disc storage unit introduced by IBM United Kingdom, Ltd., 101, Wigmore Street, London, W.1, for use with the IBM 1410 and 7000 series data processing systems, each of which can use five of the units. In this form of store data are recorded in a pattern of 250 concentric tracks on magnetic discs with reading and writing by the access arms seen in the accompanying illustration. Data can be transferred between the storage unit and the computer at a speed of up to 75,000 characters per second with the 1410 computer, or 90,000 characters per second with the 7000 series, these speeds being considerably in excess of those of magnetic tape units.

Previous random access storage units have had from one to three access arms which serviced the whole file of magnetic discs by moving up and down from disc to disc as well as in and out from track to track. The IBM 1301 has an access arm for each disc surface, eliminating the need for vertical access motion, and the entire 'comb' of forty arms moves in unison. There are 250 tracks on each surface and the discs of the IBM 1301 can therefore be thought of as a nest of 250 cylinders, each one holding up to 112,000 characters. The cylinder concept means that data stored on discs will be arranged differently. Instead of storing it on adjacent discs to minimise vertical movement of the access arms, on the IBM 1301 data will be stored on the same or adjacent cylinders. Access time within one cylinder is between 0 and 34 milliseconds and access time from one cylinder to another is between 50 and 180 milliseconds. Therefore the longest time that it can take to obtain any record in the whole store of up to 280 million characters in a five-unit installation is only 214 milliseconds.

[Reply Card No. 1089]

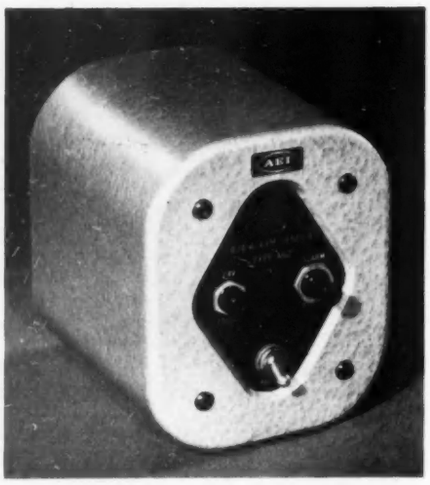
Sheared Cold Reduced Sheet

COLD reduced steel sheet is now being sheared to any width required between ⅛in and 24in by Stourbridge Rolling Mills, Ltd., Stourbridge, Worcs., and supplied in coil or flattened and cut to length to order. The sheet thickness range is 0·104in and thinner, and the qualities are drawing extra, deep drawing, and E.D.D. stabilised. By arrangement, "Galvatite" and "Stelvetite" (galvanised and plastic coated respectively) made by John Summers and Sons, Ltd., Sholton, can also be supplied.

SHORTER REPORTS *(Continued)*

Radiotelephone Alarm Sender

MANY small vessels with radiotelephone equipment at present carry a two-tone whistle for sounding the alarm signal which precedes transmission of a distress message, and is the means whereby automatic alarms are triggered in other ships and coast stations. It has been recommended that all United Kingdom ships with radiotelephones should be fitted with alarm generating equipment by January 1, 1962. A



Battery-operated, two-tone generator for marine distress warning signals

compact transistorised device for this purpose is announced by Associated Electrical Industries, Ltd., Crown House, Aldwych, London, W.C.2. This is the alarm generator type A62 made by the Marconi Department of the A.E.I. Telecommunications Division. It is fully approved to British Post Office specifications for a non-integral electrically coupled device and will modulate any radiotelephone transmitter. The United Kingdom specification for an alarm signal generator to which the A62 unit conforms was prepared by the Ship's Wireless Working Party. It emits the recognised C.C.I.R. signal of two alternating tones of 1300 and 2200 c/s, each lasting for 250 milliseconds and continuing for thirty to sixty seconds.

Only two controls are used in operating the unit—a switch to connect the output of the generator to the input of the radiotelephone transmitter, and a push button to initiate the alarm signal. The duration of the signal is controlled by a thermal relay. It can be monitored aurally by a built-in miniature loudspeaker.

The unit operates from the normal ship's 24V battery supply. It is housed in a metal cabinet, as illustrated, measuring 5·4in by 4·2in by 5·25in, and is readily installed in any position on a bulkhead or bench. Weight of the unit is 3 lb 10 oz. No extra equipment is required apart from a twin battery cable and three-core screened cable to connect the signal output to the microphone circuit of the transmitter.

[Reply Card No. 1096]

Fuel Oil Filter

A FUEL oil filter introduced by R. F. Landon and Partners, Ltd., David Road, Poyle Trading Estate, Colnbrook, Slough, Bucks, for pressure jet and vapourising oil burners is illustrated here. Its filter medium is a special resin-impregnated high density paper which is designed to give a filtration efficiency of 98 per cent, allowing no dirt capable of causing wear or jet blockage to pass. The paper density is such that a very large quantity can be compressed into a small space to afford maximum filtration area within a cover of conventional size. The nominal rate of flow is 5 gallons per hour.

The filter has a diecast aluminium alloy body with a steel cover held by two bolts. Fuel enters the housing through a boss on one side and passes through the filter paper. Clean fuel collects in the centre of the element and flows

Oil burner fuel filter fitted with a resin impregnated paper element and having a nominal rate of flow of 5 gallons an hour

through a duct on the top of the element to the outlet of the housing. An extension of the duct to the middle of the filter creates a compartment where a considerable amount of air can collect without any danger of it entering the fuel pump.

[Reply Card No. 1100]

Tube Railway Signalling Developments

PROGRAMME machines for control of signalling are now in operation at East Finchley on the Northern line of London Transport. Two sequence machines control the signalling of southbound and northbound trains respectively through the junction area, where there are connections to the Highgate rolling stock depot and to British Railways freight yards.

Desk unit for remote control of programme machine signalling tube trains

The sequence machines work in conjunction with a time machine on the principles described in our January 17 and October 24, 1958, issues. Goods trains are included in the programme machine rolls, but are actually signalled by push buttons in the Leicester Square supervision room, where approach of a goods train is notified by a buzzer warning initiated by the appropriate programme machine.

Controls for the East Finchley machine are not on the Leicester Square signalling panel, as with previous Northern Line installations, but on a separate desk unit (illustrated). Normally this is not connected to either sequence machine, but it can be switched to one or the other by means of push buttons. An illuminated indicator shows to which machine the desk unit is connected. This facility allows push button signalling of tube train movements to be used if necessary (from the signalling control panel), or the mode of operation of a programme machine to be changed so that the junction is switched to " first come first served " working.

As well as the programme machine control push buttons, the desk unit contains three rotary switches. These switches can be used to set up the train number of any train to be cancelled, the three switches controlling " units," " tens " and " hundreds " columns respectively. When the number is set up, a " cancel " button on the desk unit is depressed, causing the number of the train selected to appear below the signalling control panel in the position relating to the appropriate programme machine. The desk unit can then be disconnected, but when the programme machine train number coincides with that on the panel (known as the " train cancel visual ") the machine will cancel that train without further action by the supervisor.

Should a train number be set up for cancellation and subsequently found to be in error, it can be erased by reconnecting the desk unit and pressing a " cancel erase " button.

The signalling control panel at Leicester Square also now contains push buttons for controlling the signalling at Archway, where, as at East Finchley, the signalbox has now been closed.

The East Finchley and Archway signalling was designed and installed by Mr. R. Dell, chief signal engineer, and his staff under the general directions of Mr. C. E. Dunton, chief civil engineer, London Transport.

Vapour Cooled Valves for Industrial Heating

Low consumption of cooling water is achieved in the latest Redifon 50kW and 100kW heavy-duty induction heaters by the use of vapour-cooled triode oscillator valves manufactured by the English Electric Valve Company, Ltd., Chelmsford. The 50kW heater, operating at 400-500 kc/s, uses an BY1102 valve, and the 100kW model (180-220 kc/s) has two of these valves in parallel.

The valve maker states that the water consumption required by the boiler units of the vapour-cooling system is approximately one third that of conventional water cooled valves. As the outlet water temperature from the units is higher than from conventional water cooling jackets, an air-to-water heat exchanger can be used at a higher transfer efficiency. The boiler unit in the 100kW equipment provides cooling facilities for both valves, in a twin assembly which has a water flow of only 3 gallons per minute. Distilled water is used in the boiler to prevent the formation of scale on the valve anode.

The Redifon heaters are designed for difficult induction heating loads requiring very loose coil coupling and high r.f. currents, such as in non-ferrous melting and heat treatment. The range of frequencies available enable these work loads to be heated very rapidly. In addition, accurate case-hardening to very shallow depths can be achieved on items such as crankshafts and ring gears, which cannot be achieved at lower frequencies.

[Reply Card No. 1092]

Identifying Aircraft Radar Echoes

TRIALS are being conducted at the Ministry of Aviation's experimental block at London (Heathrow) Airport of a method for integrating information derived from automatic triangulation d/f equipment with the display on a standard air traffic control radar screen. The triangulation equipment is the PVT-2 system of Standard Telephones and Cables, Ltd., Connaught House, Aldwych, London, W.C.2 (THE ENGINEER, September 16, 1960, page 456) which gives an automatic and instantaneous fix on an aircraft as soon as a transmission is received from it.

Triangulation d/f monitor and joystick control (left) alongside standard air traffic control radar

In the present trials the d/f equipments are at Frogmore Hall, Herts, and adjacent to the experimental establishment at Heathrow.

Signals from these points are carried by landline to the PVT-2 synthesiser, and the composite triangulation picture is viewed by closed-circuit television on a screen adjacent to the air traffic control radar console.

A " joystick " control unit operates with the PVT-2 and radar console displays. By operating the joystick as soon as a fix is shown on the PVT-2 monitor screen, a spot can be moved across it to mark the fix. This spot is duplicated on the standard A.T.C. radar screen, thus identifying an otherwise anonymous radar blip. The marker may be a spot, a cross, a circle or any one of a number of symbols which are generated electronically in the control unit. As seen in Fig. 2, the joystick control is placed in front of the PVT-2 monitor display and close to the radar P.P.I. The manual action required to mark a triangulation fix takes only a second or two, depending upon the skill of the operator. A standard air traffic control radar is used and requires only slight modification to enable it to reproduce the various marker symbols.

Subject to successful completion of the present series of tests, Standard Telephones and Cables, Ltd., states that the equipment described above could be made available almost immediately. Two or more wideband c.a.d.f. (commutated aerial direction finder) stations are required, and may be u.h.f., v.h.f., or combined u.h.f./v.h.f. according to airfield needs. No co-operating equipment is necessary in the aircraft, all of which come into the triangulation picture automatically provided they carry the statutory minimum of radio communication apparatus. The system has already undergone testing by the R.A.F., by whom a report is being prepared.

[Reply Card No. 1097]

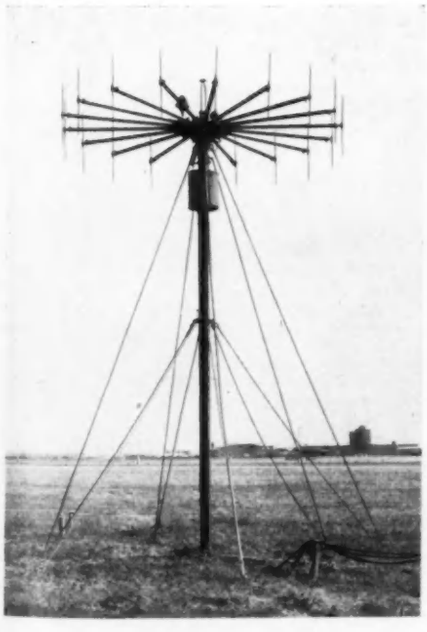
Industrial Colour Television

FURTHER development of the E.M.I. colour television camera shown last year at the Instruments, Electronics and Automation Exhibition has led to the introduction by E.M.I. Electronics, Ltd., Hayes, Middlesex, of a mobile remotely controlled industrial version. The camera contains three vidicon tubes operating on the dichroic mirror system described in our issue of June 3, 1960, page 933. A complete channel as illustrated consists of a camera in a dustproof casing, with pan and tilt head if required ; a control cubicle ; and a remote control panel. The system will operate on 405, 525 or 625 lines. Colour pictures can be displayed on a 21in receiver or on large screen projectors up to 18ft by 12ft.

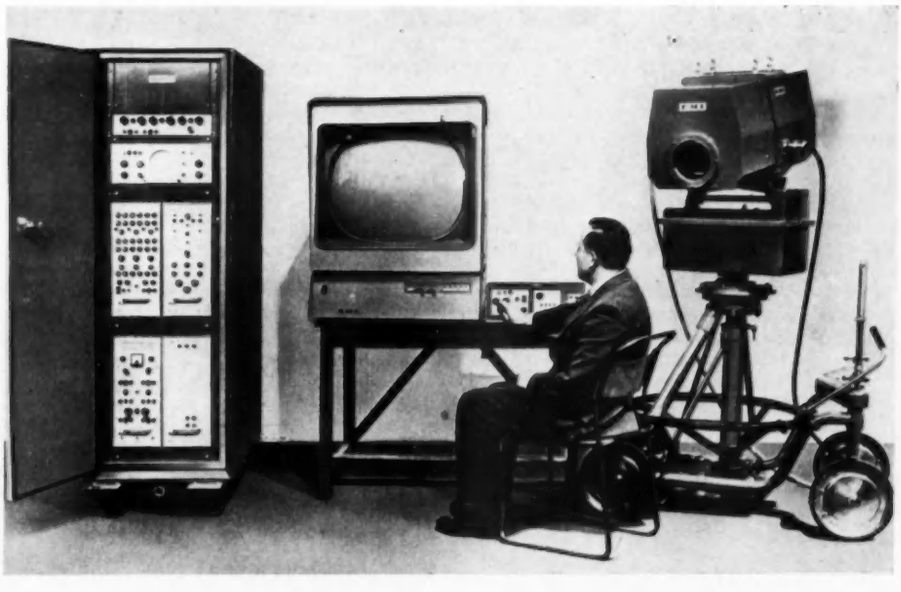
Introduction of this camera in its present form recognises the importance of colour information in many industrial processes, and the value of such information being presented at a distance from the actual operation, where there is no risk to the observers. The units necessary to operate the camera are individually mounted into metal cases, each 24in deep by 18in high by 9in wide. Each case contains a fan for cooling and runners which enable the units to be withdrawn for servicing. As the units are coupled together with flexible cables, the equipment remains fully operational when withdrawn. The cases have an interlocking system which enables them to be built up as a free standing unit. For many purposes it is more convenient to house all these units in a cubicle, as shown in the illustration, which can be either fixed or mobile. The cubicle is 6ft 6in high by 3ft deep by 2ft wide with doors that can be locked. An air intake filter and extractor fan are incorporated in the cubicle. Distance between the cubicle and the camera may be 300ft.

The remote control unit consists of three panels mounted together in one assembly measuring 19in by 6½in by 9in deep. Operation of the camera is possible at distances up to 1000ft. Functions of the panels are as follows : type 217, master gain, master black level, iris control and censor/transmit switch ; type 864, optical focus control and turret lens selector pushbuttons ; type RA605/1, spring-return switches for operating the pan and tilt head mechanisms, and manual/automatic panning selector switch. Panning range is adjustable at the head from 10 deg. to 345 deg., and the camera can be driven between the stops by moving the selector switch to " automatic." As the camera is remotely controlled, a viewfinder is not provided, but a portable picture monitor can be plugged in for setting up.

[Reply Card No. 1093]



Aerial of automatic d/f triangulation system installed experimentally at London (Heathrow) Airport



Components of industrial colour television system, showing (left to right), control cubicle, picture monitor, assembly of remote control panels, and camera on pan and tilt head

INDUSTRIAL NEWS

Iron and Steel

According to the latest figures issued by the Iron and Steel Board there was a continued weakness in the demand for steel during June this year. Production was at a rate of 447,500 tons a week compared with 466,100 tons a week in May and with 466,400 tons a week in June, 1960.

Steel production in the first six months of the year amounted to 12,216,000 tons, the Board says, rather less than was expected. In the first six months of last year production amounted to 12,386,000 tons. The fall of 1½ per cent was not evenly spread throughout the country. Pig iron production during the first half of this year totalled 7,935,000 tons compared with 7,873,000 tons in the first half of 1960.

Exports of steel have been moving upward, the Board states, in spite of a strong and growing competition from producers abroad. The amount exported in May, 293,000 tons, was the highest reached since the war except for the month of October, 1959, when, the Board adds, exports had the fortuitous help of a strike in the United States steel industry. With imports continuing to decline, net exports of steel are moving strongly upwards. During the first five months of the year they were at a rate of 224,000 tons a month compared with 192,000 tons a month during 1959, the previous best year.

Fire Prevention

In his statement which accompanied the annual report for 1960 of the Fire Protection Association, Mr. R. G. Harman, the chairman, said that despite the Factories Acts, the Public Health Act and other measures the Government now had in hand, it could be several years before some measure of safety was ensured in every building if those responsible waited until they were compelled by law to put their houses in order. He was commenting on the record of fires in 1960, when, for the second consecutive year, the nation's fire damage had cost around £44,000,000.

The statement goes on to mention in particular the large-loss fires which account for such a large proportion of the total annual fire damage. The Association's annual surveys showed, Mr. Harman said, that these fires could with some regularity be attributed to the same few causes, principally lack of means of discovering an outbreak in its early stages in the absence of employees, and lack of means of confining the fire to its area of origin. Industrial managements claimed, he added, that subdivision of the large areas they required for production was wasteful of space and economically unsound. While these were cogent arguments, Mr. Harman said, the Association believed that much more could be done both to limit the size of areas which would be exposed to a single outbreak and to reduce the risk of fires breaking out and spreading. Managements relied on architects and production specialists for the layout of their buildings and plant and would take their advice. These consultants, therefore, could themselves be instrumental in improving fire protection standards and they could obtain much inprovement with little extra cost if the risk of fire was included in the other considerations which governed their designs and layouts. The Association already enjoyed the wholehearted co-operation of the Royal Institute of British Architects, Mr. Harman said, and would be appealing to management and production consultants to enlist their support in its efforts to reduce the risk of fire and the consequent damage done to British industry.

Machine Tools

The monthly figures published by The Machine Tool Trades Association show that in the first four months of 1961 new orders for machine tools have moved erratically, concealing the trend, but it now seems, the Association says, that the tendency was downward. In this period the value of net new orders received was 17 per cent less than the very high value a year earlier. The reduction in the value of new export orders was 13 per cent. New orders continued to exceed deliveries, however, and order books continued to lengthen but much more slowly than during 1960. In the first four months of 1961 the value of orders on hand increased by rather more than £4,000,000 ; in the first four months of 1960 the increase was about £23,000,000 and in the whole of the year nearly £50,000,000. Deliveries of machine tools continued to increase in the early months of 1961. In April the value of deliveries was 46 per cent more than in April, 1960, which included the whole of the Easter holiday, and in the first four months of 1961 was 31 per cent more than a year earlier. Export deliveries, which had increased faster than deliveries to the home market in 1960, were only 14 per cent higher in the first four months of 1961 than a year earlier ; deliveries to the home market were 37 per cent more.

Wage Claims

The Confederation of Shipbuilding and Engineering Unions has decided to lodge immediately claims for extra pay and a shorter working week for more than 3,000,000 engineering and shipbuilding workers. The resolution demanding the wage increase was approved at the Confederation's annual conference held at Eastbourne last month (THE ENGINEER, June 30, 1961). The Confederation has announced that "nothing less than £1 a week" is the figure it has in mind for the wage demand. This claim will be coupled with a demand for a reduction in hours from the present forty-two hour week to a forty-hour week. The Confederation is also to make a claim for an equal rise for some 150,000 women engineering workers, who have previously been granted only a proportion of the increase awarded to the men. This claim, it is understood, will be retrospective.

The wages demand by the Confederation follows some six months after the last settlement (THE ENGINEER, December 30, 1960, and January 13, 1961.).

Earlier last week, the railway shopmen's committee of the Confederation announced its decision to lodge a new claim for a "substantial" increase in pay for some 120,000 railway workshop employees, whose basic wages range from £9 a week for labourers to £10 2s. for craftsmen.

The Confederation of Shipbuilding and Engineering Unions has also announced that because of a breakdown in negotiations over the pay of craftsmen employed by Scottish local authorities, it has recommended a number of unions to give notice of strike action as from September 1, 1961. Craftsmen in England and Wales have been awarded an increase of 5d. an hour, but the Scottish offer was only 3d.

Works Accident Statistics

The Royal Society for the Prevention of Accidents has recently published "Works Accident Statistics, Part 2, Records and Analysis." Part 1, which dealt with accident definition and investigation, was published in 1958. Part 2 analyses the purposes for which accident records are compiled and advances a system for recording data in a manner which will provide the safety officer with a source of useful and assimilable facts about accident causes and injury locations.

The extent of the problem is shown, the Royal Society says, by the fact that, in 1960, there were no less than 190,266 industrial accidents which were serious enough to necessitate their being reported to the Factory Inspectorate. There were many more, it adds, which were, fortuitously, of a less serious nature.

Indian Industries Fair

The Board of Trade has announced that it is providing an official United Kingdom exhibit and organising a large commercial display of British products at the Indian Industries Fair, the international trade exhibition which opens in New Delhi on November 14. The Board has taken a site at the Fair of 66,000 square feet on which the United Kingdom Pavilion, covering about 40,000 square feet, is being built.

The Pavilion will be in two major sections, the first being devoted to the official exhibit, "Britain : India's Industrial Partner," which will cover about 11,000 square feet. The object of this exhibit will be to outline Britain's continuing contribution to the industrialisation of India and it will include sections on finance, transport, communications, power, industrial production, health and knowledge. This section will lead into the commercial display, filling the second section, in which British firms and Indian firms with British connections will stage individual displays of their products on stands being provided by the Board of Trade. This section will cover about 26,000 square feet and accommodate forty-nine firms indoors and two out of doors. The wide variety of products displayed by these firms, the Board states, will amplify the theme of the official display.

Ten other firms with British connections will exhibit independently in their own pavilions on adjacent sites. Their exhibits will bring the area devoted to exhibits of goods deriving from Britain up to a total of 112,000 square feet. Structural units for the Pavilion are being supplied by Taylor Woodrow (Building Exports), Ltd.

Twenty other nations, including the United States and the Soviet Union, have booked space at the Fair, which is due to last for six weeks, closing on January 1, 1962.

PERSONAL AND BUSINESS

Appointments

MR. D. H. LINDLEY has been appointed contracts manager of Small and Parkes, Ltd.

MR. ARTHUR MAILER has been appointed chief engineer of R.M.S. " Transvaal Castle."

MR. DAVID H. ROWNEY has been appointed public relations officer for Tempered Group, Ltd.

BLAW KNOX, Ltd., has announced the appointment of Mr. John C. Grist as commercial manager of the construction equipment division.

MR. A. T. DAVY has been appointed general manager of T. and T. Vicars, Ltd. He has also been appointed director of the company.

MR. R. H. DAVIES has been appointed deputy general manager (Liverpool) domestic appliances division of the English Electric Company.

MR. A. A. FARRELL has been appointed director and general manager of Plessey Ireland, Ltd., and also a director of Plessey Sales, Ltd., Dublin.

MR. KENNETH BOREHAM has been appointed sales manager of Tempered Rubber Components, Ltd., a member of Tempered Group, Ltd., of Sheffield.

SIR HAMISH MACLAREN, former director of electrical engineering at the Admiralty, has been appointed a consultant to Associated Electrical Industries, Ltd.

MR. R. S. PHILLIPS has joined the instrumentation division of Evershed and Vignoles, Ltd., as chief of development dealing with electronic process control equipment.

MR. O. E. TRIVETT, A.M.I.E.E., A.M.I.Prod.E., has been appointed General manager of Gamet Products, Ltd., Colchester, one of the 600 Group of Companies.

MR. R. MORRISON, company secretary, and Mr. A. H. SIMPSON, general sales manager, have been appointed to the board of directors of Woodfield Rochester, Ltd.

MR. DAVID H. BRAMLEY has been appointed production director of Geo. Salter and Co., Ltd., in succession to Mr. P. P. C. Drabble who is retiring at the end of July.

THE TEES SIDE BRIDGE AND ENGINEERING WORKS, Ltd., announces the appointment of Mr. J. C. Hall, M.I.Struct.E., and Mr. E. P. Gallagher, A.M.I.C.E., to the board of directors.

THE ELECTRICAL DEVELOPMENT ASSOCIATION announces the appointment of Mr. Neville Robinson to the new post of assistant director. He will take up his duties in September.

SIR BEN LOCKSPEISER, MR. C. F. HODSON and MR. W. H. WEST have been appointed to the board of J. H. Shand, Ltd., of Axminster, a member of the Staveley group of companies.

HENRY SIMON (HOLDINGS), Ltd., announces that Mr. F. J. Sullivan has been appointed a director of Turbine Gears, Ltd. He was previously commercial manager of Turbine Gears, Ltd.

MR. C. H. G. HAYWARD, general manager of the combustion division, and MR. H. HARDING SMITH, general sales manager, Edwin Danks and Co. (Oldbury), Ltd., have been appointed directors.

MR. T. CARLILE has been appointed general manager of Renfrew, Dalmuir and Dumbarton Works of Babcock and Wilcox, Ltd., following the retirement of Mr. D. D. Cruickshank, from that position.

MR. MICHAEL LEWIS, chairman of De Vere Holdings, Ltd., has been elected chairman of Oxley Engineering Company, Ltd. Mr. S. Stansfield has been appointed deputy chairman and managing director.

RHODES, BRYDON AND YOUATT, Ltd., announces the appointment of Mr. M. J. B. Hodgson, A.M.I.Mech.E., as area manager for the Midlands at its offices in Griffin House, Ludgate Hill, Birmingham, 3 (telephone Central 8911).

ALLIS-CHALMERS GREAT BRITAIN, Ltd., announces the appointment of Mr. Timothy H. Kindersley, A.M.I.C.E., as chief engineer of the company's engineering products division at its London office at Salisbury House, London Wall, E.C.2.

THE GEORGE COHEN 600 GROUP, Ltd., announces that Mr. John P. Bolton has been appointed managing director of its Australian subsidiary, George Cohen Sons and Co. (Australia) Pty., Ltd., of Sydney. He succeeds the late Mr. C. A. Bell.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces that Mr. C. O. Boyse, M.I.C.E., M.I.E.E., on relinquishing his appointment as managing director of the Automatic Telephone and Electric Company, Ltd., has been appointed an executive director of B.I.C.C. from July 6, 1961.

Business Announcements

C. A. PARSONS AND CO., Ltd., has moved its London office from 56, Victoria Street to 40, Broadway, Westminster, S.W.1.

MARCO CONVEYOR AND ENGINEERING COMPANY, Ltd., announces that Mr. H. S. Atter, its London and Home Counties representative, is now acting in a similar capacity throughout England and Wales.

WILLIAM SMITH TOOL AND STEEL COMPANY, Ltd., has completed an entirely new factory wing, adjoining its main premises in Harrow Street, Sheffield, designed exclusively for the production of cast steel cold chisels.

E. GREEN AND SON, Ltd., Economiser Works, Wakefield, announces its appointment as sole licensee in the United Kingdom for the manufacture of Sinter fans and Schicht axial blowers designed by Kuhnle, Kopp and Kausch, Frankenthal.

CRANES (DEREHAM), Ltd., Dereham, and CRANE FRUEHAUF TRAILERS, Ltd., North Walsham, have moved their London office from Sicilian House, Southampton Row, to 8, York Buildings, Adelphi, London, W.C.2 (telephone, Trafalgar 1781).

ROBERT CORT AND SON, Ltd., Reading, states that as from July 15 it is closing down its Reading Bridge Works and transferring all activities and head office to new shops and offices erected alongside the existing foundry and shops at Elgar Road.

THE BRITISH REINFORCED CONCRETE ENGINEERING COMPANY, Ltd., has formed a company in Nigeria to draw wire and to manufacture electrically welded steel wire mesh (BRC Fabric and Weldmesh). The factory is to be constructed on the Industrial Estate at Ikeja, near Lagos.

ELLIOTT-AUTOMATION, Ltd., announces the formation of a new department in E-A Automation Systems, Ltd., which will specialise in automation in the paper and plastics industries. Mr. D. A. Mackintosh, who was formerly with Formica, Ltd., has been appointed head of the department.

THE RHEOSTATIC COMPANY, Ltd., Slough, Bucks, and ROBERTSHAW CONTROLS S.A., of Geneva, announce that in order to complement their respective ranges, agreements have been entered into covering two-way co-operation in a wide variety of devices in fields of common interest.

PYE, Ltd., announces that the vibration division of W. Bryan Savage, Ltd., a member of the Pye Group of Companies, has become a separate company. It will be known as Pye-Ling, Ltd., and is a joint undertaking launched by Pye, Ltd., of Cambridge, and Ling Temco Electronics Inc., of Dallas, Texas, U.S.A.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., Crown House, Aldwych, London, W.C.2, has made an agreement with Facit Electronics AB of Sweden as a result of which the electronic apparatus division of A.E.I. has been appointed sole agent in the United Kingdom and British Commonwealth (except Canada) for Facit Carousel memory, high-speed tape and punch and high-speed reader.

STEEL FABRICATORS (CARDIFF), Ltd., announces the formation of Steelfab (France) S.A., at 72, Avenue J. J. Rousseau, Houilles (S.O.), France, as a manufacturing and sales company, established to meet the increasing demand for agricultural and industrial equipment in France. Steel Fabricators (Cardiff), Ltd., is a member of the Adamant and Western Group of Companies.

THE ENGLISH ELECTRIC COMPANY, Ltd., has announced that its welding business has been coordinated in a newly formed welding equipment division which has been set up at the company's Accrington Works (telephone, Accrington 33241). The manager of the division is Mr. R. H. Boughton, the chief engineer is Mr. F. Mullery and the sales manager is Mr. E. H. Ayres.

ELLIOTT-AUTOMATION, Ltd., and C. A. PARSONS AND CO., Ltd., have joined the British Space Development Company. Elliott-Automation, Ltd., will be represented on the technical committee by Mr. W. R. Thomas, M.I.E.E., A.F.R.Ae.S., joint general manager of Elliott Brothers (London), Ltd. C. A. Parsons and Co., Ltd., will be represented by Dr. H. M. Finniston, F.I.M., deputy research director.

C. A. PARSONS AND CO., Ltd., Heaton Works, Newcastle upon Tyne, has signed a licence agreement with Zallea Brothers, Delaware, U.S.A., for the manufacture and sale of thinwall-bellows expansion joints of Zallea design. The agreement provides for the marketing of the British made products in the United Kingdom, the European Free Trade Area, and British Commonwealth (with the exception of Canada).

Contracts

ANGLIN-NORCROSS MARITIME, Ltd., Canadian associates of Holland and Hannen and Cubitts, Ltd., of London, has been awarded a 4,000,000 dollars (£1,450,000) contract for a new shopping centre at Halifax, Nova Scotia, which is due for completion in only sixteen months ; the shopping centre will have fifty stores and shops in a heated mall.

FAIREY AIR SURVEYS, Ltd., is to photograph most of Oxfordshire under a contract awarded by Oxfordshire County Council. The area concerned is the entire county north of Swyncombe on National Grid Line 190, approximately 422,000 acres. The photographs will be taken at a height of 4000ft and will have a contact scale of 1/8000 or 8 miles to an inch.

BRISTOL AIRCRAFT, Ltd., has received from the Royal Swedish Air Force Board an order for Mk. II Bristol " Bloodhound " surface-to-air missiles. The Mk. I was ordered in 1958 in order to gain experience of the problems of a guided weapon anti-aircraft system ; the Mk. II will have an enhanced performance particularly, due to its continuous-wave radar, against low-flying targets.

ROLLS-ROYCE, Ltd., is to supply a " large " number of eight-cylinder supercharged oil engines rated at 335 h.p. at 2100 r.p.m. for use in Thornycroft " Mighty Antar " tractors ordered by the War Office. The " Mighty Antar " was originally designed with a V-8 engine, the Rover (Rolls-Royce) " Meteorite," but British Army vehicles have hitherto used the six-cylinder Rolls-Royce engine.

EDMUND NUTTAL, SONS AND CO. (LONDON), Ltd., has been awarded contracts by the Board of the Firth of Clyde Dry Dock Company, Ltd., for the civil engineering works for a new dry dock, repair quay, and tanker cleaning depot, at Great Harbour, Greenock. The civil engineering work, which is estimated to cost in excess of £2,250,000, will start within the next few weeks, and is due for completion at the end of 1964. Messrs. Burns-Babtie Partners, are the engineering consultants for the project.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., and the AUTOMATIC TELEPHONE AND ELECTRIC COMPANY, Ltd., have received contracts respectively for the radio and the carrier equipment of an s.h.f. multi-channel radio telephone system between York and Newcastle, via Darlington, in the North Eastern Region of British Railways. This will be the first communications link of its kind on British Railways, and the first multi-channel system in Britain for private traffic on 7500 Mc/s. There will be repeater stations at Woolmoor between York and Darlington, and at Ferryhill between Darlington and Newcastle. Three channels will be dropped in each direction at each repeater. Some particulars of the preliminary planning for this service were given in THE ENGINEER of January 16, 1959, page 111. The system is designed for a maximum capacity of 300 telephone channels, but initially 180 will be in operation. Equipment will be duplicated on a main/standby basis, with automatic changeover in the event of failure. The number of valves used is relatively low and the r.f. transmission circuits employ 1 microwave klystron per unit equipment, both factors which reduce the probability of equipment failure. The telephone channelling equipment will use transistors throughout and printed wiring cards for mounting components. A survey of the route to establish final tower heights and system performance is now being carried out by Marconi engineers, and the contract is scheduled for completion in fifteen months.

Awards

THE two Sir Alfred Herbert Travelling Scholarships for this year have been awarded to two production engineers, Messrs. D. J. Amery and J. E. Connor, who are employed at the Telephone Works of The General Electric Company, Ltd., in Coventry. These scholarships are awarded annually by the Machine Tool Trades' Association in commemoration of the ninetieth birthday of the late Sir Alfred Herbert.

Death

WE regret to announce the death of Mr. George E. Sandland, which occurred on July 8. Mr. Sandland had been with the International Nickel Company (Mond), Ltd., and its predecessors for thirty-five years, and was particularly identified with the company's Development and Research Department. Latterly he was prominent in the nickel plating labelling scheme, which is now reaching a state of maturity.

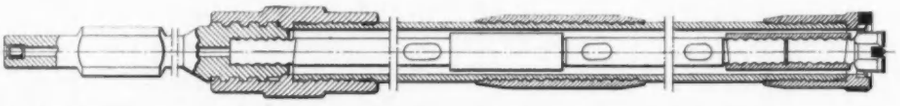
CONTINENTAL AFFAIRS

by Our Continental Editor

Two Rock Drilling Techniques

Here we describe a technique known as "overburden drilling," in which bedrock can be blasted in-situ, *without first removing the overburden. The technique has been developed in Sweden and introduced into this country by Atlas Copco, Ltd. The article concludes with a brief description of a device for shaft raising known as the "Jora Lift."*

A NOVEL technique in rock drilling known as "overburden drilling" has been introduced into this country by Atlas Copco, Ltd., following its successful use on various Swedish constructional sites. The aim of the technique is to drill, charge and blast bedrock, without first removing the overburden, whether the latter is dry or submerged. The diagram shows the drilling equipment which enables this to be done. Basically it consists of a hollow drill with a second drill mounted concentrically inside it, such that its teeth extend to form a pilot bit to the ring bit of the hollow drill. The two are driven together as a single unit, through the overburden, and the hollow drill is keyed into the rock. Then the inner drill alone is used to drill a hole into the rock sufficiently deep to place the charge. The inner or extension drill as it is called is then removed, leaving an open connection down to the rock, formed by the outer drill, or drill-pipe as this outer one is termed. In practice a plastics pipe is inserted in the drill pipe, and replaces it so that it is not destroyed by the blast.



Drill pipe and extension drill inside it, showing the two drill bits at one end, the shank adapter at the other and a coupling sleeve intermediately

The drill-pipe comprises cold-rolled tubes of alloy steel of 2 $\frac{13}{16}$in and 2 $\frac{3}{16}$in external and internal diameters respectively; the ring bit is screwed on, and has an outer diameter of $3^{15}/_{32}$in or 3$\frac{3}{8}$in, with ten tungsten-carbide tips. The tubes have rope threads at each end, and are joined by external coupling sleeves.

The extension drill is the company's standard "Sandvik Coromant" 1$\frac{1}{4}$in diameter drill steel with a $\frac{1}{4}$in diameter central hole for flushing. The extension bit is 2in in diameter, and it protrudes 1in beyond the ring bit.

An important element in the system is the shank adapter which is used to fasten the two drill-rods to the drill itself and thus transmits both rotary and percussive forces to one or both tools. The top drill-pipe is screwed on to the inside rope-thread of the adapter sleeve, which in turn is screwed on to the external trapezoidal thread of the shank adapter. The top extension rod screws on to the internal rope thread of the shank adapter. When the rods are screwed off the adapter, the adapter sleeve comes off first; thus either both rods or just the extension rod can be connected up and operated.

The rock drill has separate air motors for percussion and rotation. The drills used are the company's standard types BBE–41 or the heavy duty BBE–51. The illustration shows a typical application, with two drills mounted in frames on a crawler-tracked vehicle, and completed holes in the foreground; in this particular case a trench is to be excavated.

Generous high-pressure flushing with water is considered to be an important factor in achieving the high rates of progress claimed for the technique. The explosive charge is loaded pneumatically through the plastics pipe, the drill-pipe being "collared" into the rock before this is done, and removed afterwards. Forty or fifty cartridges of explosive can be loaded at a time; heavier charging is generally needed than for conventional rock drilling, and some charge is positioned in the overburden.

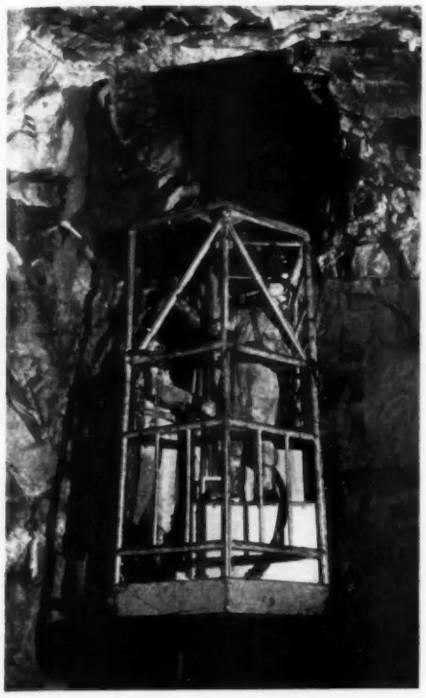
The outstanding success of overburden drilling up to now has been in the construction of the Lindö canal in Sweden. Here 4 miles of canal nearly 200ft wide by 33ft deep required the excavation of clay, sand, gravel and moraine totalling about 5,000,000 cubic yards, and of rock about 250,000 cubic yards. The rock lay at varying depths below the other materials, conditions being such that dry excavation would have proved uneconomic. Overburden drilling was therefore resorted to, to blast the bed rock *in situ*, and excavation was then undertaken successfully by dredger. Secondary blasting proved unnecessary. The average performance of a three-man crew operating two machines was fifteen holes per shift, with an average depth of 43ft per hole, 25ft drilled through clay, 8ft through moraine, and 10ft through rock. Short-delay blasting was employed. In the largest explosion, 4750 holes were charged with 120,000 lb of dynamite, using 12,000 millisecond blasting caps. Nearly 1,000,000 cubic feet of rock was displaced by this explosion, together with almost 2,500,000 cubic feet of overburden.

Other promising applications of the overburden drilling technique concern mineral prospecting; subsoil testing and site exploration for proving rock, or, for instance, obtaining undisturbed soil samples beneath boulders; underwater drilling; grouting; and anchoring, for instance, steel-sheet-piles to rock in a convenient manner.

Device for Shaft Raising

Shaft-raising is one of the most hazardous and uncomfortable tasks in rock tunnelling. Atlas Copco, Ltd., has introduced equipment, which we illustrate, known as the "Jora Lift" to make such work safer and to carry it out more speedily.

The basic idea is not new, and consists of



The "Jora Lift" cage ascending the shaft raise

drilling a hole, say 3in to 6in in diameter, from the surface to the base of the shaft, through which a rope is lowered. The rope supports a "cage" or "lift," which is hoisted to the face after each blast, with the miners inside it. The face is scaled from protected positions inside the cage, which can be propped against the walls of the shaft to give a stable platform for drilling. When the next charge is ready, it is lowered and moved to a safe position, the rope is removed, and the charge is fired. Such a method was used in constructing a shaft on the Breadalbane hydro-electric scheme, and was described in THE ENGINEER of July 25, 1958.

The "Jora Lift," however, has introduced improvements to this method. Principally, the lift has its own compressed-air-driven hoisting gear mounted under the working platform. Relatively expensive hoisting machinery and a hoist driver on the surface are thus dispensed with, and signalling from the cage to the surface is unnecessary, so safety is improved. The cage is comprehensively equipped with compressed air services, anchorage bolts and chains, telescopic legs, &c., and is intended for re-use on successive projects. An air-motor-driven winch is, in fact, installed on the surface (or upper level) to winch the hoist rope, and this winch can be used in an emergency to lower the cage. This winch is mounted on a sledge; a second sledge is positioned under the shaft to receive the cage when it is lowered. An automatic reel at the lower level controls the air hose trailing from the cage.

Experimental Oxygen Blowing Installation

In order to investigate the metallurgical phenomena and reaction kinetics of oxygen blowing, the Fried. Krupp concern, Essen, in 1957 installed an experimental plant which has since undergone a number of elaborations and improvements.

The installation covers a floor area of 2200 square metres in the form of a bay 72m long and 30m wide. Its location is such that it can be supplied with iron from either a cupola or an electric furnace which stand in the adjoining bays on either side. The size of the melting equipment was chosen larger than normal laboratory size, in order to make the results applicable to full-scale plant, without incurring excessive expense.

For the preliminary melting of the pig iron and additives a rotary furnace is provided which consists of a horizontal drum about 4·5m long with an internal diameter of 1·1m. The ends, in the form of truncated cones, have central openings of 0·48m and 0·36m diameter respectively; additionally, the end with the smaller hole has a 40mm diameter tap hole extending from the outside to near the bottom of the furnace.

The 0·2m-thick lining consists of an acid, hydraulically setting, tamped material, together with a wear lining over the cylindrical portion.

A steplessly variable drive enables the roller-mounted furnace to be rotated in either direction at 0·5 to 5 r.p.m. Rotation can be maintained in either direction even during the tilting which is carried out towards the tap hole side by means of a tilting cradle, up to an angle of 80 deg. The whole furnace can quickly be exchanged for a spare. A portable exhaust duct can be positioned in front of the furnace. The combustion gases are drawn off to the chimney through a recuperator.

At the ends opposite the tap hole two oil burners are hinged; one can quickly be converted to burn gas, and is used mostly for pre-sintering and pre-heating of the furnace. The other burner with an oil consumption of up to 220 kg per hour melts the charge. This burner has primary and secondary atomisation and works with fuel oil pressure of 5 atmospheres. Compressed air for atomisation is preheated electrically to 120 deg. Cent. while combustion air is heated to 400 deg. to 500 deg. Cent. in the recuperator.

Both burners incorporate a water-cooled oxygen lance which operates with gas pressures of 1 to 15 atmospheres. A charging platform is arranged on the burner side. A charge weighing 3 tonnes can be used and can be melted in two hours. Specific oil consumption is 80 kg to 100 kg per tonne.

The converter is a vertical lined container with an outside diameter of 1600mm and an overall height of 2700mm, and having a lining 0·25m thick at the sides and more at the bottom. Like the furnace it holds a charge of 3 tonnes. A lateral hole for slagless tapping is incorporated. The ratio of charge to reaction volume is 1 : 1.

A tamped tar-dolomite or tar-magnesite lining is employed. Temperatures in the melt are measured continuously. A gas burner has been fitted which can be mechanically positioned. This burner preheats the converter in order to maintain its temperature at 1000 deg. Cent. during the waiting periods resulting from the operation of the melting furnace.

A water-cooled exhaust hood is mounted above to carry away the fumes. Its position is adjusted electro-hydraulically to vary between contact with the converter rim to a gap 450mm wide. A water-cooled duct takes the fumes to a spray cooler and thence to the dust extraction plant, comprising a double cyclone washer. Connection between the spray cooler and cyclone is by means of an asbestos expansion bellows with brass reinforcement and silicon rubber gaskets.

The oxygen lance is mounted on a swivel bracket, and its height above the melt can be varied during the blowing. The head is such that the nozzle can be changed easily and quickly during a run. A working platform at the level of the converter top facilitates the charging of additions and the taking of samples of metal and slag.

Dust extraction by electrostatic methods was excluded on the ground of cost. As it was expected that dust could be removed more readily and efficiently if the gas flow were kept moderate, it was necessary to find ways of reducing it. With an open chimney, flue gas quantities of up to 30,000 cubic metres per hour were observed, corresponding to an excess air ratio of 11. With the extraction hood described, this quantity was reduced to one-tenth. The flue gas temperatures varied between 900 deg. and 1500 deg. Cent. at the inlet, and between 500 deg. and 900 deg. Cent. at the outlet. These high temperatures are reduced in the spray cooler which also removes the larger dust particles. The flue gases then pass through the annular washer. This is designed to wet the fines, of which about 80 per cent are below 0·8 micron. It consists of a cylindrical casing with concentric double cone insert forming an annulus through which the gas flows in an upward direction. Water is sprayed in at the bottom, also in an upward direction, and directed straight at the annulus. Because of the high speed of flow at that point, the water is drawn completely into the gas stream even at low rates of gas flow. The sudden pressure drop causes violent turbulence which helps to wet the particles. In the diffuser these are then coagulated into larger droplets which run off into an intermediate bottom and are siphoned off and drained into a collecting basin. Since only the larger droplets separate out at that point it is necessary to provide a second cyclone to separate out the smaller ones. The washing water is also collected in the basin. The clean gas enters the suction side of the extraction fan with a final dust content of less than 50 mg per cubic metre, so that the originally brown fumes are now blown off in the form of practically clear gas.

A central control desk comprises all the necessary controls and instrumentation. The control desk is in a raised position so as to make it possible to observe the flame during a blow and supervise the work on the charging platform. All controls are interlocked and their action is electrically indicated.

The converter can be tilted in two directions, the vertical (blowing) position being indicated by a green light showing. The oxygen lance can be moved up or down in two speed ranges, the movement being controlled by limit switches. The exhaust hood is oil-hydraulically operated and similarly controlled by means of limit switches. Both the exhaust fan and the water pump for the dust extraction plant are controlled from the desk. Two manual control valves admit oxygen to the rotary furnace and to the converter respectively. A pressure gauge and manual valve on the melting furnace itself provide a fine adjustment. Incoming oxygen at 0 to 150 atmospheres gauge is reduced to 0 to 30 atmospheres by a reducing valve, and further reduced to 0 to 16 atmospheres for the blowing operation. Oxygen flow per hour and per charge are also indicated and the daily total recorded. The temperatures of the melt, of the lining, and of the flue gases are also recorded, as well as the cooling water temperature of the oxygen lance. Excess cooling water temperatures cause a warning to sound.

The amount of cooling water for hood, lance, and dust extraction, is recorded. Air pressure under the hood is indicated over a range of -6mm to $+10$mm H_2O.

A profile indicator shows the lance position between 0 and 1·5m above the melt by way of a transducer.

The equipment is completed by a weighing machine, ingot casting pit and ingot moulds, and provision for pre-heating the ladles, and the taking, registration and preparation of samples of metal, slag, and gas.

German Aromatics Plant

Plans for the construction of an aromatic chemicals plant at Dinslaken have been confirmed by Standard Oil Company of California and The British Petroleum Company, Ltd. The plant will be operated by a newly-formed partnership of the respective subsidiaries BP Benzin und Petroleum A.G. and California Chemical G.m.b.H., to be known by the short designation Deutsche BP und California.

The contract for the construction of the plant has been awarded to the German engineering and construction firm of Lurgi, and completion is scheduled for mid-1962.

Feedstock will be supplied from the adjoining BP Ruhr Refinery. The plant will have a designed capacity of 14,000 metric tons of high purity paraxylene employed in a wide field of manufacture including synthetic fibres, fabrics films and plastics. It will use a manufacturing process developed by the California Research Corporation, research subsidiary of Standard Oil Company of California. Construction of a similar aromatics plant in Kent has already been announced. The two projects involve an expenditure of £7,000,000.

CONTINENTAL AFFAIRS *(Continued)*

International Comparison of Productivity

ONE of the topics of discussion between the productivity centres of the "Six" in recent months has been the promotion of productivity by means of international interfirm comparison.* It is considered that such comparisons provide an appropriate focal point around which diverse and irregular productivity work in many branches can be re-organised on a more systematic basis. The modern firm employs many different methods for controlling the efficiency of its production processes. Such control is based mainly upon comparison over time ; the most recent results are compared with data relating to earlier periods, and conclusions are drawn regarding the trend of productivity. Only in a few exceptional cases is actual performance compared with scientifically determined norms.

This is not surprising ; the establishment of objective norms for all the activities of a firm requires a great deal of time and money.

Comparisons over time may show quite clearly that part of the production process has been carried out more economically than in a previous period, yet there is no outside standard by which to judge whether the methods being used are really the most efficient. Interfirm comparisons provide the answer ; such comparisons have therefore been developed all over the world in the course of the last ten years in many branches of industry, commerce, agriculture, transport, &c.

In brief, the procedure consists in having comparable data for a sufficiently representative period of time collected from a number of firms by a reliable agency. After statistical analysis, the data are generally presented in a report, the main section of which is the economic interpretation of the results. This report is sent to all participants, but of course their anonymity is scrupulously safeguarded ; the results are indicated under code numbers and each firm knows only its own number. Complete discretion is observed.

This kind of comparison between firms reveals clearly whether any doubts about a firm's efficiency which the management may have had were justified or not.

In many cases, it also gives a representative picture of the sector ; and although this is not the primary aim of the comparison, it is nevertheless of considerable importance. Many of the comparisons which have been carried out reveal very large differences in efficiency, which merely increase when the operations of the various departments of the firm are examined in detail. Moreover, these differences are not always consistent ; at operation A Firm No. 3 may be the most efficient, while at operation B Firm No. 5 is in the lead ; Firm No. 1, with the best overall "score," may in fact only lead in, say, four out of ten operations covered by the study.

These differences at departmental level tend to cancel each other out, so that the overall results of the firms may not vary greatly ; thus at the level of the firm's overall performance there is a danger of overlooking important differences which do in fact exist, and which can only be revealed by detailed interfirm comparisons. Such comparisons enable firms to locate their weak points, bring to light untapped reserves and show the head of the firm to which part of the production process action to reduce costs or improve results should be directed. Comparisons can be launched in different ways, either individually by each firm, with or without recourse to management consultants, or co-operatively by agreement and collective action among participants. Many examples of successful practical action in both forms are known. Some individual firms have made quite outstanding improvements in efficiency, while the productivity of all participating firms has markedly increased. Again, in many cases the mere fact of taking part in a comparison provides a strong stimulus arousing the participating firms to a new awareness of the problems facing their industry or trade. Finally, for a small or medium-sized firm which cannot have a large planning or research staff, interfirm comparison provides a means of thoroughly assessing the firm's position, and of obtaining advice on its methods of management and operations—advantages which are normally enjoyed only by the larger firms.

Many different methods have been evolved for carrying out this work. Comparisons can, for instance, be based on the accounting data available in every firm, each category of costs being compared in turn. This, unfortunately, depends upon how far the accounting systems of the participants are uniform. If the accounting systems have previously been standardised—and this generally takes some time—this method can undoubtedly give interesting results.

However, the great progress which has been made in interfirm comparison, particularly in indistry, is due to the development of another method, which is based on the collection of more detailed and essentially quantitative basic data.

These data include detailed labour times for a given unit of production, following a clearly defined subdivision of the production process into its elements, consumption of raw materials per unit of production, machine utilisation, analysis of idle time, transport times, range of goods produced, percentage of turnover of the ten largest customers, &c. This method is independent of the accounting system used by participants, since it is founded on the basic data essential for any proper cost accounting system. It is true, of course, that these quantitative data do not give the full picture of a firm's potentialities, but experience has clearly shown that they provide an excellent basis on which to undertake interfirm comparisons and to classify participants in terms of productivity.

These basic data can be processed in different ways. They can be expressed in the form of ratios of various "input" factors per unit of production of the firm (labour productivity or machine productivity), or more advanced statistical methods (such as regression analysis) can be used, making it possible to determine the relative importance of the factors affecting the firm's results.

These basic data are generally collected by means of questionnaires, and in all cases personal contacts are made in the participating firms.

Growing economic integration within Europe increasingly impels heads of firms to invite their foreign colleagues to take part in interfirm comparisons. Moreover, it may be that in certain branches of industry the number of firms in a single country is too small for a representative comparison to be possible without the risk that participants can be identified. Because of certain technical difficulties (e.g. disparity of exchange rates, different incidence of capital and labour factors) comparisons based on quantitative and technical data offer the greatest possibilities at international level. It must be understood that such studies do not aim at comparing the global productivity of sectors in different countries, but once again, seek to compare one firm with another. Since participation is purely voluntary, the participants in any one country are very unlikely to be truly representative of that country ; what is more important is that each participating firm should be able to compare its own productivity figures with those of the others.

The main difficulty with international comparisons is organisation. It has been possible to develop national comparisons because, among other reasons, heads of firms have known which specialised organisations they should consult. For international comparisons, the procedure is much less well established ; but the productivity centres of Belgium, France, Germany, Italy, the Netherlands and Luxembourg, have made arrangements for their specialists to be able to get in touch with each other and carry out nternational interfirm comparisons in a co-ordinated manner.

* *International Interfirm Comparisons.* By M. Nanninga. Paris : European Productivity Agency, Château de la Muette, 2, rue André-Pascal, Paris (16e). Obtainable from H.M. Stationery Office, P.O. Box 569, London, S.E.1. Price 24s.

Cargo-Passenger Liner "Prinses Margriet"

Now on her maiden voyage from Rotterdam, whence she sailed on July 15, is the "Prinses Margriet" which is the new flagship of the Oranje Line. The ship was built by Scheepswerf in Machinefabrick 'De Merwede' N. V. at Hardinxveld-Gressendam and has the following main particulars : length overall, 457ft; length between perpendiculars, 421ft 11in ; breadth moulded, 61ft 1in; depth to main deck, 41ft 1in ; draught, 28ft 3in ; deadweight, 7760 tons ; service speed, 17 knots ; gross tonnage, 9335 ; and net tonnage, 5056. Of full scantling design the liner, which was named and launched on December 10, 1960, by H.R.H. Crown Princess Beatrix of the Netherlands, has been built to Lloyd's Register classification with ice strengthening. Accommodation, which is fully air-conditioned, is provided amidships for the passengers and senior officers while the junior officers and crew have their quarters aft. A total of 111 passengers is carried in one class and in one- or two-berth cabins, all of which are outside rooms and are fitted with private toilet facilities. Other accommodation for the passengers includes a lounge, dining room. library and writing room, enclosed promenade, sports, and sun decks. The crew number 101.

Five holds are provided for cargo, arranged three forward and two aft of the engine-room, and they have a total grain capacity of 377,868 cubic feet. In addition there are seven deep tanks of 34,644 cubic feet total capacity for the carriage of edible oil. MacGregor hatch-covers are fitted and the cargo handling complement includes one 20-ton, two 10-ton, six 5-ton, and four 3-ton derricks operated by eight 5-ton and four 3-ton hydraulic winches. The liner is fitted with Denny-Brown stabilisers and is fully equipped for passing through the St. Lawrence Seaway and the Great Lakes, and links Rotterdam with Chicago via Southampton, Le Havre, Montreal, Toronto, Cleveland, and Detroit.

Propulsion is by a "Verolme-M.A.N." ten-cylinder, single-acting, two-stroke, supercharged diesel engine developing 8600 b.h.p. at 130 r.p.m., and having a bore and stroke of 700mm by 1200mm. The main cooling water pumps include one of 400 tons per hour, one of 325 tons per hour for the cylinder cooling and one of 100 tons per hour for circulating the piston cooling water. Electrical power is developed by three 400kVA, 440V generators, each driven by M.A.N. diesel engine developing 480 b.h.p. at 400 r.p.m. Two of the generators have shaft extensions which drive Reavell air compressors rated to deliver 240 cubic metres per hour at 30 kg per square centimetre. There are also two 114kVA emergency generators driven by 126 b.h.p. Kromhout diesel engines. An oil-fired Scotch boiler supplies steam for heating purposes and there is a distiller which provides 80 tons of fresh water from sea water per twenty-four hours. Ventilation of the engine-room is effected by four Woods Aerofoil fans, each of 31,000 cubic metres per hour capacity, and there are also a 20,000 cubic metres per hour fan placed in the funnel and an additional fan of 6000 cubic metres per hour rating.

THE AMERICAN SCENE

By Our American Editor

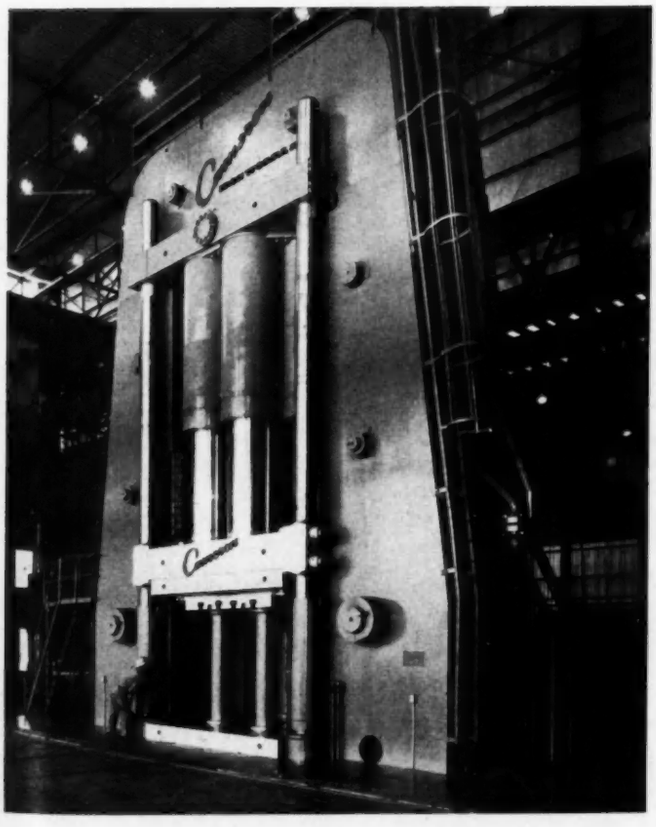
20,000-Ton Hydraulic Forging Press in Texas

AN unusually large and powerful forging press recently went into operation at the Cameron Iron Works in Houston, Texas. This 20,000 ton forging press is backed up completely with auxiliary equipment, including a 4000 ton blocking and forming press and a 6000 ton shaping and punching press.

The significance of the new press lies in the fact that it opens a new horizon, making possible and practical the forging of such products as jet engine parts, turbine cases, shafts, landing gears, atomic power plant parts, in sizes and lengths and shapes heretofore impossible, and with controlled and uniform physical properties so far not obtainable in large size forgings. The first forging from the press was an aircraft shaft weighing 6000 lb made out of A286 stainless steel. It was 12ft 6in long, shaped like a funnel, with the large end approximately 3ft in diameter and the shaft end 12in in diameter, with an 8in hole running along the axis of the shaft.

The Houston works of the company already had presses of 750, 1500, 4000, 5000 and 11,000 tons capacity. The 11,000 ton press, built to Cameron specifications, was at the time of its construction by far the largest of its kind ever built. It is equipped with two side rams which exert a load of 4000 tons in addition to the 11,000 ton down-acting ram and auxiliary piercing ram which can exert a load of 3000 tons.

(Below)—20,000-ton hydraulic forging press at the Cameron Iron Works in Houston, Texas



(Above)—Closed die set mounted on 20,000-ton Cameron hydraulic forging press

The new press is claimed to be the world's largest multiple-ram forging press equipped for forging steel, refractory metals, high density and other special alloys in closed dies. Its huge capacity both as to tonnage and dimension makes possible an extension of the practice of closed-die forging with its many benefits. When desired, the operator can drop the main piercing ram assembly out of the new press, which leaves a 56in hole in the main bolsters, in the moving platen and the top platen. In this manner, the works can produce an extrusion up to 30ft long and up to 56in in diameter, limited to 30,000 lb weight. The throttling or flow control of the machine allows it to be operated anywhere within a range of 0 to 400ft per minute ram speed.

The frame of the press is 50ft from bottom to top and 31ft from side to side. The bottom platen is 12ft from front to back and 12ft from side to side. The machine has a daylight of 15ft and a stroke of 90in. The total weight of the press is 3,158,250 lb, and, with the concrete foundation, its overall weight is more than 4,000,000 lb. The main frame is made up of twelve sections of 60 tons weight each, resulting in a total weight of 1,440,000 lb.

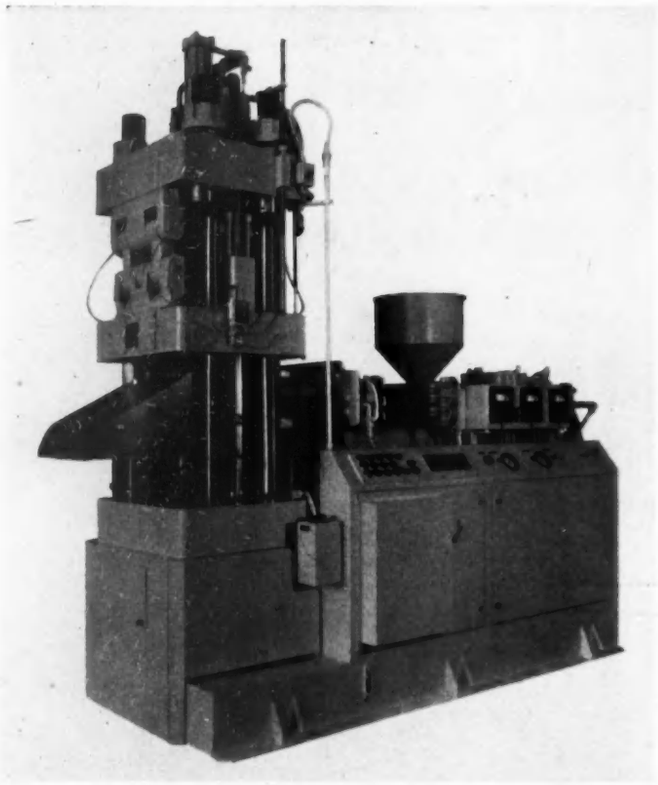
Once the side rams have been installed, they will exert 5000 tons each, which, under intensification, will go up to 7500 tons each. The piercing ram inside the main ram has a down-acting range of 4200 tons. The four pull-back rams have a gross force of 940 tons. The net stripping force is 400 tons, and the bottom knock-out punch has 650 tons capacity.

The hydraulic system of the new press employs four 4500 gallon Babcock and Wilcox bottle accumulators, three being pure air and one air-and-water units. The pumping system comprises three Aldrich 750 h.p. quintuplex plunger pumps.

THE AMERICAN SCENE *(Continued)*

Automatic Injection Moulding Press with Screw Plasticator

The F. J. Stokes Corporation, of Philadelphia, has developed an automatic 300 ton injection moulding press, which incorporates a screw plasticator with an original design of drive-mechanism. The screw plasticator is a clean, in-line system in which all the components of the drive-mechanism are rigidly mounted. By eliminating the customary bulky thrust-bearing through which the hydraulic ramming pressure is conventionally applied to the screw, maintenance is reduced and thrust overloads are avoided.



Stokes 300-ton automatic injection moulding press incorporating a screw plasticator

In the new design, a single straight shaft links the screw in the plasticising cylinder with the piston in the ram cylinder which is situated directly behind it, on the same axis. The piston and shaft rotate within the ram cylinder as the screw rotates in the plasticising cylinder. The screw is driven by a hydraulic motor mounted directly above the shaft, to the rear of the plasticising cylinder, through a stationary right-angle gearbox. The driving gear engages the screw-shaft by means of gibs and splines, which permits the shaft to move axially forward and back through the gearbox as the screw advances or retracts within the plasticising cylinder. The hydraulic motor provides infinitely-variable speed control and protection against torque overload.

The screw plasticator in the press substitutes mechanically-produced heat for a large portion of the electrical heat-input required in earlier injection cylinders. This produces a thoroughly plasticised and completely homogenised material with less electrical power, making the new press especially desirable for use with vinyl and other heat-sensitive plastics. The screw-plasticised material, also, can be injected at lower pressures, which results in strain-free moulded products. The screw, moreover, allows the moulder to use dry-blended colours, adding them in the hopper to the clear basic material. This enables him to reduce his inventory, since he needs to stock only the clear plastic, colouring it as production requires.

The screw not only blends and plasticises the material, but also conveys it to the front of the injection cylinder, the screw retracting along its axis as it feeds the material forward. When the proper amount for a full shot has been brought to the front of the cylinder, the screw is moved forward, conveying the material through the nozzle into the mould. The plasticising assembly can be moved along its axis hydraulically. A hand-operated valve moves it quickly to the rear, without disconnecting. The entire unit can then be swivelled easily by hand to an axis clear of the press section, in which position the cylinder can be quickly and easily purged. This design is of particular value when the material is to be changed at the end of a run and offers a great convenience to an operator faced with short production runs and frequent changes between different pieces or different colours.

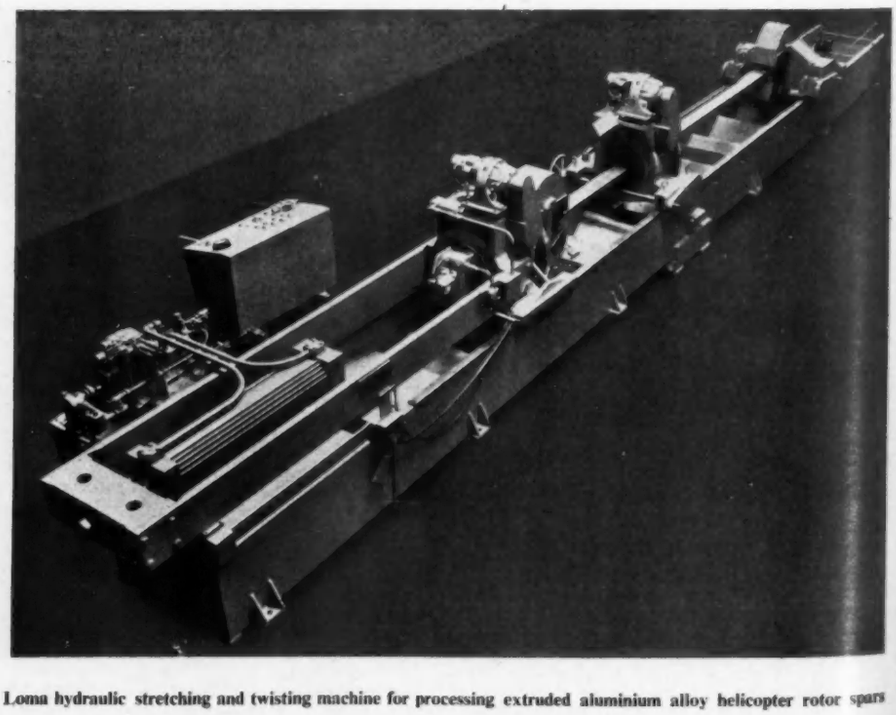
The new machine incorporates all of the features of earlier Stokes automatic injection presses, including the positive nozzle shut-off. This feature has two advantages : it permits the moulding of nylon and similar materials without "drooling" or stringing and without nozzle change ; it also permits pressure pre-packing of the injection cylinder simultaneously with the cooling cycle. This shortens injection time by permitting instantaneous withdrawal of the screw, even before gates are fully set up in the mould.

Hydraulic Stretching and Twisting Machine for Spar Sections

A wide range of aircraft and similar spar sections can now be shaped under very precise control due to the development of a large hydraulic stretching and twisting machine by the Loma Machine Manufacturing Company of New York. The accompanying illustration shows a representative machine employed by an American manufacturer of helicopters to process extruded aluminium rotor spars.

The equipment shown has a 400,000 lb stretching capacity and a 200,000in-lb torque capacity. The stretching speed is infinitely variable up to 25in per minute, while twisting is performed at the rate of $\frac{1}{4}$ r.p.m. The machine comprises a fabricated steel bed with fully machined ways, a hydraulically moveable head-stock with twisting device, a non-rotatable tailstock, moveable by crank, and a special intermediate steady-rest with a closed gripping head and a twisting device. All the various gripping jaws are opened and closed by air cylinders.

A special feature of the new machine is its intermediate head which is moveable along the entire bed so that it can be engaged at any point of the spar. With this device a pre-determined portion of the spar can be twisted or de-twisted by itself, making it possible to produce two or more different helix angles over the full length of the spar.



Loma hydraulic stretching and twisting machine for processing extruded aluminium alloy helicopter rotor spars

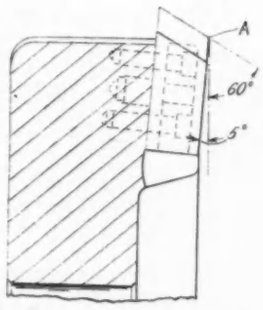
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

MILLING CUTTERS

871,369. November 27, 1957. MILLING CUTTERS, Firth Brown Tools, Ltd., Speedicut Works, Carlisle Street East, Sheffield 4, Yorkshire, and John Edwin Stratford, of the Company's address.

The invention relates to face milling cutters comprising a body of generally cylindrical form arranged for rotation about the axis of the cylinder and a set of independently constructed cutters secured to the body with their cutting edges radiating from the axis. It is an object of the invention to provide an improved construction of inserted tool face cutters which facilitates free disposal of the chips or cuttings, and one which lends itself to heavy roughing cuts. In the face cutter described the cutting edges have a positive axial rake and a negative radial rake. The cutting edges have a positive axial rake (10 deg. on the particular example shown in the drawing), and a negative radial rake (10 deg. in the example which together with the rake of the sides makes a total radial rake or shear angle of 20 deg.). There is also an angle of 60 deg. between the cutting edge and the end face. The effective part of the cutting edges of the



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cutters is that in the region *A* and it will be seen that this region is wholly or mainly outside the compass of the body so that cuttings or chips may pass outside and are not likely to be trapped between the body and the work. The rake, shear and clearance angles given to the cutting edges assist in directing the chip flow away from the body of the cutter. Other rake angles are however within the scope of the invention.—*June* 28, 1961.

ELECTRIC TRACTION

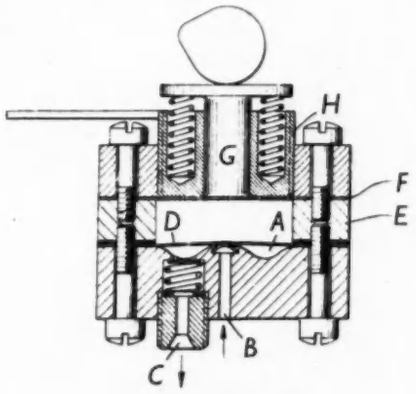
871,306. October 26, 1959.—CONTROL OF RECTIFIED CURRENT ELECTRIC LOCOMOTIVES, Forges et Ateliers de Constructions Electriques de Jeumont, 5, Place de Rio de Janeiro, Paris, France.

This invention deals with the control of rectifier locomotives wherein off-load tap-changing is achieved by grid control of the rectifiers. It has been the practice to use contactors capable of operating under load in case of failure to suppress conduction in a rectifier, and this has increased the weight and bulk of equipment. The principal object of the invention is to prevent operation of the tap-changing contactors when there is risk of them operating under load, and it also provides a large number of control steps by a small number of contactors. The scheme described is based on the use of the JH camshaft controller and comprises the automatic checking by means of relays of the grid currents of the rectifiers involved when a tap change is to be made. In the event of any abnormal condition being detected, the camshaft motor starting circuit is interrupted.—*June* 28, 1961.

PUMPS

871,343. December 23, 1957.—DIAPHRAGM PUMP, Paul Schaurte, Vaduz-Bartlegrosch, Liechtenstein.

It is the principal object of the invention to provide a diaphragm pump with a constant stroke and in which the capacity and output can be varied independently of the speed of the drive shaft. Referring to the drawing, the lower housing of the pump has a trough-like pump chamber *A*. A central fluid inlet *B* has its inner end covered by a screen. The outlet C communicates with the pump chamber via a spring loaded check valve. A resilient diaphragm *D* is clamped between the lower housing and an annular housing *E*, the other side of which carries a diaphragm *F*. The chamber formed between the two diaphragms is filled with oil, so that a movement of the upper diaphragm will be transmitted to the lower to reciprocate it on the pump chamber *A*. The upper



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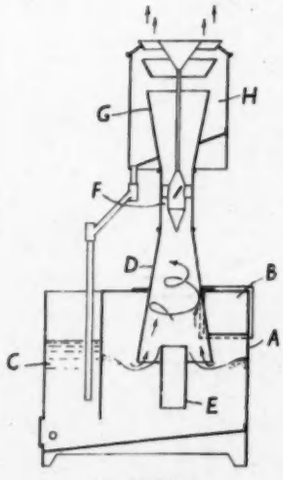
diaphragm is reciprocated by a plunger *G* which has a flange in engagement with an eccentric is driven by a suitable motor. The plunger slides on an annular member *H*, the lower surface of which covers the diaphragm *F* around the plunger. The member *H* has bores in which coil springs are inserted for maintaining the plunger in constant engagement with the eccentric. The member *H* is screwed into the housing and by turning it the distance between its lower surface and diaphragm *F* can be varied. By raising or lowering the plunger member *H* the effective stroke is altered on the oil in the control chamber and thus the pumping reciprocation of the lower diaphragm.—*June* 28, 1961.

DUST SEPARATORS

870,812. July 3, 1959.—DUST SEPARATORS, Dust Control Processes, Ltd., Darlington, County Durham. (*Inventor : Robert Ashman.*)

The primary object of this invention is to provide a dust separator which utilises the forces of centrifugation washing and inertia to produce a high extraction efficiency with a low resistance to gas flow and wherein the ratio of the volume of treated gas to the size of the separator is high. The dust separator, according to the invention, is shown in the drawing. In operation the dusty gas passing through the tangential inlet *B* to the cyclone chamber *A* enters in a swirling movement whereby the coarser particles are removed by centrifugal force and settle at the bottom of the liquid in the chamber. The liquid



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level is so adjusted relatively to the lower edge of the gas outlet duct *D* that there is only a narrow gap through which gas can pass and the swirling gases produce a fine spray of liquid which is carried into the outlet duct. Any drops of liquid too large to be carried along with the gas stream fall into the catchment pipe *E*. The mixture of dusty gases and fine spray pass at a progressively increasing velocity to the agglomerating section *F* of the outlet duct and due to the reduced cross sectional area at this zone the velocity is high and the gases are subjected to a high degree of turbulence which causes the particles of dust and liquid to agglomerate into larger closely bonded particles of dilute slurry. The rotary movement of the gases passing up the outlet duct is assisted by vanes and the rotating gases pass into the divergent section *G* of the duct beyond the high velocity section *F*. In this divergent section the velocity of the gases gradually decreases and the agglomerated particles pass by centrifugal force to the periphery of the duct *G*. The gases and particles are then discharged into the expansion chamber *H* where the particles are extracted by a combination of centrifugal and inertia forces. The particles in the form of a dilute slurry are returned through to the container *C* or to a settling tank or to drain.—*June* 21, 1961.

ELECTRONICS

871,615. September 5, 1956.—DETECTORS AND COUNTERS, Burndept, Ltd., West Street, Erith, Kent. (*Inventor : John Louis George Beaumont.*)

This invention relates to electronic apparatus for detecting the arrival of objects at a defined position and counting them, and rests on the fact that a thermionic valve oscillator of the tuned grid, tuned anode type will cease to oscillate if its tuned circuits are put sufficiently out of tune with each other ; and on the further fact that the current taken by the oscillator in the non-oscillatory condition is greater than that taken when it is oscillating. In the drawing the oscillator is shown as a triode *A* having in its grid circuit a crystal *B* and in its anode circuit a parallel tuned circuit *C* and resistance *D*. The tuning of the anode circuit is adjusted by a trimmer *E*, so that the oscillator is near the condition of non-oscillation. Suitable frequencies can be found in the range 10 kc/s to 30 Mc/s. For the purpose of the invention there is added to the anode circuit a single pick-up

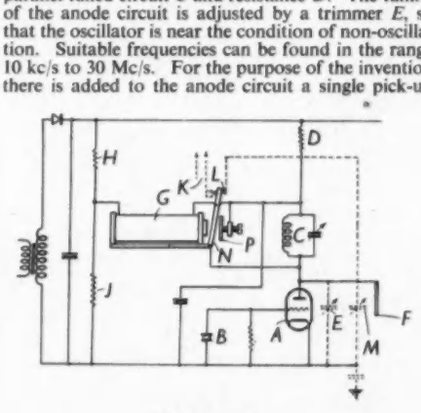

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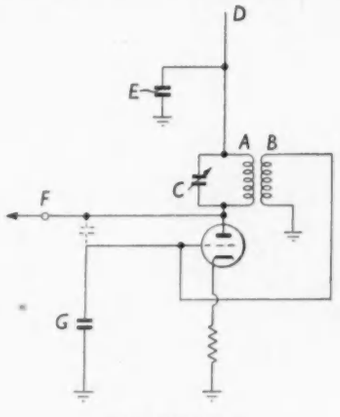
plate or search plate *F*, so that the capacitance of this plate to earth becomes a part of the capacitance of the anode circuit. The object to be dealt with should enter the electrostatic field between *F* and earth, and so modify the field as to change the effective capacitance of the plate. The shape and disposition of the search plate or plates will be adapted to the form of the object to be dealt with and the route by which it is brought into proximity to the pick-up plate. Also for the purpose of the invention there is connected to the anode circuit the winding *G* of a relay. To increase sensitivity the winding is connected between the junction of resistance *D* and tuning circuit *C* and a point on a potentiometer *H*, *J* so chosen that in the absence of any article, little or no current flows in the relay. When the potential of the junction changes due to a change in the current through the oscillator the relay responds. In so doing it may close contacts such as *K*, or open contacts, and thereby put in action any electrically operated device, for example a tap controlling the flow of liquid, or a counter. An oscillator adjusted so near to the point of non-oscillation as to be prevented from oscillating by the additional capacitance brought into its circuit by the arrival of an object may not begin oscillating again when the object passes out of proximity to the plate *F*. To eliminate

this possibility the relay may be arranged to modify, in this case decrease, the capacitance of the anode circuit when it responds. This may be done by contacts such as *L* which when closed connect a small capacitor *M* into the anode circuit. Or the relay armature *N* and an adjacent initially adjustable plate *P* may form a capacitor connected into the anode circuit as shown, the attraction of the armature diminishing the anode capacitance by the amount by which it has been increased by the object detected, or even more, but not so much as to restore oscillation notwithstanding the presence of the object.—*June* 28, 1961.

871,310. August 18, 1958.—OSCILLATOR CIRCUITS, Associated Electrical Industries, Ltd., 33, Grosvenor Place, London, S.W.1. (*Inventor : Frank Brian Boardman.*)

In conventional oscillator circuits of the tuned anode type, frequency sweep is obtained by varying the value of a tuning anode capacitor. However, as the anode impedance and the feedback from the anode to the grid through the anode-to-grid capacitance both increase with frequency, the amplitude of the output varies with frequency. The present invention affords a simple, yet effective means for controlling automatically the output amplitude of an oscillator and makes it possible to produce a substantially constant amplitude output over a specified frequency range such as 35 to 45 Mc/s. The invention is shown applied to a basic oscillator circuit comprising a triode valve, the inherent capacitance between anode and grid being indicated by the capacitor shown in dotted lines. A transformer having a primary winding *A* and secondary winding *B* is provided to derive from the anode voltage a grid voltage as required for positive feedback to maintain oscillation. A tuning capacitor *C* is arranged in the anode circuit for the frequency sweep operation. The high-tension conductor *D* supplying the anode is connected to earth through a de-coupling capacitor *E*. It will



No. 871,310

be seen that opposite ends of the winding *B* are at a.c. and earth, and the output terminal *F* is connected to a point between the anode and the tuning circuit. According to the invention a capacitor *G* is connected between the grid of the valve and earth thereby to provide a load for the transformer winding *B*. As the impedance of *G* decreases with frequency increase the effective value of the transformer load increases and the feedback ratio is decreased. Thus the undesirable effect of feedback increase due to frequency increase can be considerably reduced or eliminated and it has been found that over a frequency range of 35 to 45 Mc/s an output of virtually constant amplitude can be achieved by suitable choice of capacitor *G*. The influence of the added capacitance of *G* on the oscillation frequency can be readily corrected by the other impedance components such as the inductances of the primary and secondary windings *A*, *B* of the transformer. An arrangement according to the invention may also serve any desired output amplitude change. For instance if it is required to decrease the amplitude with frequency increase, this can be achieved by providing a compensating capacitor *G*, the value of which is higher than that which would produce a flat amplitude characteristic.—*June* 28, 1961.

PRESSES

87*d*,598. April 8, 1960.—VERTICAL HYDRAULIC DOWN-STROKE PRESS, Loewy Engineering Company, Ltd., 551-553, Wallisdown Road, Bournemouth, England. (*Inventor : Eduard Karl Ludwig Haffner.*)

A press, according to this invention, has two different kinds of hydraulic systems. One system includes the circuits with direct pump drive which supply fluid to the main cylinder and lifting cylinders of the press. The other system includes the circuit for the balancing cylinders which are supplied from the accumulator. This separation of the circuits makes it possible to employ water as hydraulic fluid for the accumulator, whereas the circuits of the direct pump drive operate with oil, as usual. This is advantageous in so far as a water accumulator is simple in design and less expensive than an oil accumulator. The invention is particularly useful in the case of heavy presses, where otherwise a large amount of heat would be developed by throttling of the fluid expelled from the return cylinders during the descent of the crosshead. It has been found that the economies achieved justify the installation of a separate accumulator for the balancing cylinders, including the installation of the auxiliaries for the accumulator, such as its pump and compressor. The accumulator need only be of a capacity sufficient to replenish the balancing cylinders of the press, and can therefore be comparatively small. A further advantage is that, owing to the separation of the circuits, the balancing cylinders may operate at higher pressures than the other hydraulic circuits of the press, enabling the size of the cylinders and accumulator to be reduced.—*June* 14, 1961.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

PVC-INSULATED CABLES AND FLEXIBLE CORDS FOR ELECTRIC POWER AND LIGHTING

No. 2004 : 1961. Price 7s. 6d.

ARMOURED PVC-INSULATED CABLES

No. 3346 : 1961. Price 8s. 6d. Requirements for the insulation thicknesses of 250V/440V PVC-insulated cables have been reduced in these two Standards which became effective on March 1. These thicknesses are now the same as those specified for polythene-insulated cables in B.S. 1557. Two new voltage ratings—660V/1100V and 1900V/3300V—have been added to the standard range, the lower range being for both armoured and non-armoured cables and the higher for armoured cables only. As in earlier editions, the revised B.S. 2004 deals only with round-conductor non-armoured cables, but the addition of the new 660V/1100V range has considerably increased the number of tables of dimensions. B.S. 3346, which is a new standard, deals only with armoured cables. These have shaped conductors except in the smallest sizes. It was considered preferable to publish the specifications separately because many users are likely to be concerned with one or the other but not with both.

Provision is made in both standards for either copper or aluminium conductors to be used for cables as required. Copper conductors only are specified for flexible cords. For non-armoured cables the copper conductors may be tinned or plain, as required, but only plain conductors have been standardised for armoured cables. Both standards include the usual electrical tests. Reference is made to the appropriate British Standards for detailed requirements for the conductors, insulation, sheath and armour. B.S. 3346 includes an appendix on the installation of armoured PVC-insulated cables and gives appropriate values of armour resistance in another appendix.

CENTRE-LINE—AVERAGE HEIGHT METHOD FOR THE ASSESSMENT OF SURFACE TEXTURE

No. 1134 : 1961. Price 8s. 6d. This standard has been revised in order to keep abreast of recent I.S.O. (International Organisation for Standardisation) development and A.B.C. (America, Britain and Canada) agreements. It lays down the principles by which the irregularities both of machined and "natural" surfaces can be assessed numerically and in addition gives a comprehensive insight into measuring techniques and problems. The publication provides an international means for discussing and transmitting information on roughness characteristics and assessment in addition to laying down the requirements with which surface assessment instruments should comply in order to ensure compatibility of performance.

SAMPLING OF IMPORTED IRON ORES. PART 1 : HAMMER AND SHOVEL METHOD.

No. 3278 : 1960. Part 1. Price 3s. This is the first of a series of standards dealing with the sampling of ores and is designed to meet the growing need for a standardised form of preparation of iron ore samples at United Kingdom ports. It is pointed out that the differing conditions at ports, as well as the varied nature of imported ores, limit the detail which can usefully be incorporated in a standard, but the basic principles which apply in all cases are covered.

The first part of the standard has been prepared recognising that ships of larger tonnage than hitherto will be increasingly used, necessitating more rapid methods of sampling by mechanical means. It applies to sampling of imported iron ores from ships' holds at the port of arrival immediately after arrival. Recommendations are made for the method of selection of sub-samples and the number of increments, the method of sampling, the gross sample and reduction to the certificated sample, and the final samples.

A plan of sampling and sampling reduction is included in the publication, as well as an appendix giving an example of the general procedure recommended.

PRESSURE REGULATORS FOR USE WITH BUTANE/PROPANE GASES. PART 3 : VARIABLE HIGH-PRESSURE REGULATORS

No. 3016. Part 3 : 1960. Price 5s. This publication lays down minimum safety, durability and performance standards for variable high-pressure regulators used with butane or propane in the vapour phase above 20in w.g. outlet pressure (51 *g* per square centimetre). It specifies the materials, construction, performance and tests for such regulators, and requires that a regulator complying with the standard shall be clearly and permanently marked with the manufacturer's name, symbol or trade mark, the month and year of manufacture, and the number of the standard, followed by the letter B (for Butane) or P (for Propane).

Catalogues and Brochures

THE BRITISH TRANSPORT COMMISSION, 222, Marylebone Road, London, N.W.1.—Booklet, "Modernisation Progress Report," describing and illustrating what has been achieved in the modernisation and re-equipment of British Railways over the past five years. The work is dealt with under separate sections concerned with track, motive power, signalling, passenger train services, passenger stations, shipping services, catering, and freight depots and marshalling yards.

W. G. PYE AND CO., Ltd., Granta Works, York Street, Cambridge.—Illustrated publication on the Pye argon chromatograph and associated equipment. A survey of applications is given, and references are included to technical papers on the subject of gas chromatography.

MANDOVAL, Ltd., Barrington House, 59, Gresham Street, London, E.C.2.—A comprehensive handbook on vermiculite and its uses, both in building and other industries. The forty-page illustrated booklet includes sections on the material and its properties, loosefill applications, lightweight concrete, vermiculite plasters, fire protection of structural steelwork, and high temperature insulation.

MORGANITE ELECTROHEAT, Ltd., Point Pleasant, Wandsworth, London, S.W.18.—Illustrated brochure describing "Crusilite," a self-bonded silicon carbide element material suitable for use in the construction of high-temperature electrical furnaces in the metal, ceramic, glass and other industries. "Crusilite" elements are of one-piece tubular section having a spiral as the hot zone.

MUCON ENGINEERING COMPANY, Ltd., Stonefield Way, South Ruislip, Middlesex.—Illustrated leaflet giving details of an automatic hopper level control switch for solids and slurries. It is claimed to be particularly suitable for light powders and products of low bulk density. The switch may be connected for local indication, remote signal, motor control switching, bin stock control, &c.

Forthcoming Engagements

PLASTICS INSTITUTE

Tues., July 25.—British Plastics Federation, 47-48, Piccadilly, London, W.1. Annual General Meeting 2.15 p.m. President's Reception and Conversazione, National Maritime Museum, Greenwich, 5 p.m.

Advanced Engineering Courses

Techniques of Non-Destructive Testing. PHYSICS DEPARTMENT, BRUNELL COLLEGE OF TECHNOLOGY, Woodlands Avenue, Acton, London, W.3. An evening course of eleven lectures, every Wednesday from 7 p.m. to 8.30 p.m., commencing Wednesday, October 4, 1961. The lectures will be on topics such as radiology, ultrasonics, eddy currents, magnetic methods and thermal conductivity. Fee £1.

Metal Cutting Principles. THE UNIVERSITY OF BIRMINGHAM, Institute for Engineering Production, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. A two-week course, planned by Professor Milton C. Shaw, head of the Metals Processing Division of the Massachusetts Institute of Technology, U.S.A., intended for senior production engineers. The course runs from August 21 to September 1, 1961. Fee 70 guineas, covering all residential charges and meals.

Corrosion Problems in the Electrical Power Industry. EIGHTH CORROSION SUMMER SCHOOL, Battersea College of Technology, London, S.W.11. For the first time, the Corrosion Summer School is concerned with the particular aspects of corrosion met in one industry. Starting with boiler feedwater, corrosion and its prevention are surveyed as they affect each stage of generation, concluding with transmission and distribution. The course is being held from September 25 to 28. It is hoped to arrange a visit to Central Electricity Research Laboratories, Leatherhead, on Thursday, September 28. Fee £10.

The Principles of Rotodynamic Machines. BOROUGH POLYTECHNIC, Borough Road, London, S.E.1. A course of thirteen lectures to be given on Tuesday evenings, commencing September 26, 1961, at 6.30 p.m. The course will be concerned with the principles of certain hydraulic turbines and rotodynamic pumps. It is intended for students who have previously qualified in mechanics of fluids to Higher National Certificate standard, or who hold another suitable qualification. Fee 30s.